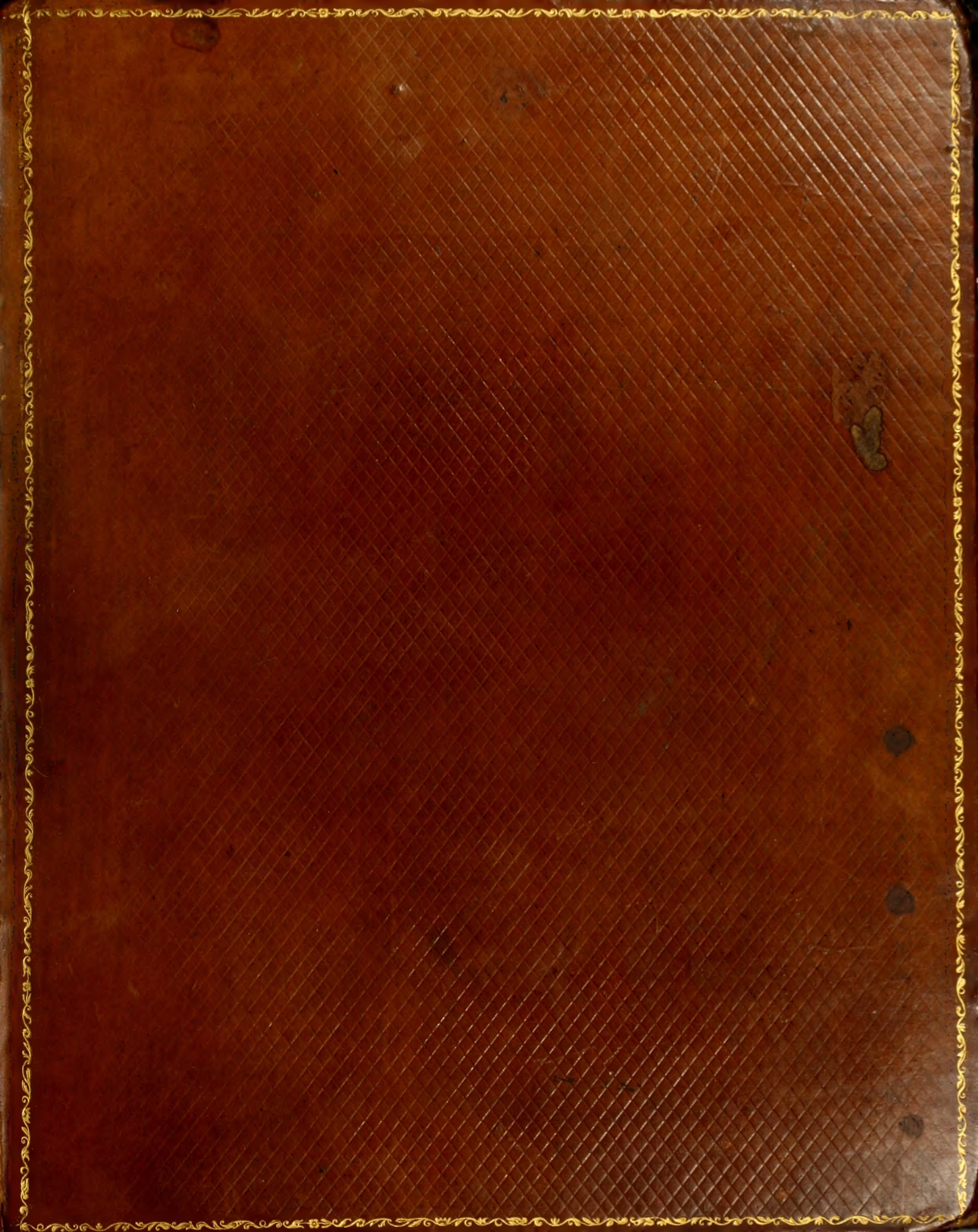

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>
> LORD BACON

BY ALEXANDER JAMIESON, LL.D.

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# L.

L, or l, the eleventh letter of our alphabet; a numeral denoting 50; and with a dash over it, 50,000.

LA, in Music, the syllable by which Guido denotes the last sound of each hexachord; if it begins in C, it answers to our A, if in G to E; and if in F to D.

LABDANUM, or LADANUM, is a resin obtained from the surface of the cystus Creticus, a shrub which grows in Syria, and the Grecian islands. It is collected while moist, by drawing over it a kind of rake, with thongs fixed to it, from which it is afterwards scraped. When it is very good, it is black, soft, and has a fragrant odour and a bitterish taste. Water dissolves about a twelfth part of it, and the matter taken up possesses gummy properties. When distilled with water, a small quantity of volatile oil arises. Alcohol may also be impregnated with the taste and odour of labdanum.

LABEL, in Navigation, a thin brass ruler used in taking altitudes. In Law, a slip of paper or parchment that holds the seal. In Pharmacy, directions for the use of medicine.

LABIAL LETTERS, those pronounced chiefly by means of the lips.

LABORATORY, in Military affairs, signifies that place where all sorts of fireworks are prepared, both for actual service and for experiments, *viz.* quick matches, fuzes, port-fire, grape shot, case shot, carcasses and grenades, cartridges, shells filled, and fuzes fixed, wads, &c. &c.

LABORATORY, in Chemistry, the room in which the artist keeps his utensils, and makes his experiments.

LABOURING, implies pitching or rolling heavily in a turbulent sea, an effect by which the masts and hull of the ship are greatly endangered; because, by the rolling motion, the masts strain upon their shrouds with an effort which increases as the sine of their obliquity; and the continual agitation of the vessel often loosens her joints, and makes her extremely leaky.

LABYRINTH, among the ancients, was a large intricate edifice cut into various aisles and meanders, running into each other, so as to render it difficult to get out of it. There is mention made of several of those edifices among the ancients; but the most celebrated are the Egyptian and Cretan labyrinths.

LAC is a resinous substance, the production of an hemipterous insect, which is found on three or four different kinds of trees in the East Indies. The head and trunk of the lac insect seem to form one uniform, oval, and compressed red body, about the size of a flea. The antennæ are thread-shaped, and half the length of the body. The tail is a little white point, from whence proceed two horizontal hairs as long as the body. These insects pierce the small branches of the trees on which they feed; and the juice that exudes from the wounds is formed by them into a kind of cells, or nidus for their eggs. Lac is imported into this country adhering to the branches in small transparent grains, or in semi-transparent flat cakes. Of these the first is called *stick lac*, the second *seed lac*, and the third *shell lac*. On breaking a piece of stick lac, it appears to be composed of regular honeycomb-like cells, with small red bodies lodged in them; these are the young insects, and to them the lac owes its tincture, for when freed from them its colour is very faint. Seed lac is the same substance grossly pounded, and deprived of its colouring matter, which is used by dyers and for other purposes; and shell lac is the cells liquefied, strained, and formed into thin cakes.

LAC *Sulphuris*, in Medicine, a sulphur, separated by acid from its alkaline solution, which renders it milder. *See* SULPHUR.

LACCIC ACID, in Chemistry, a white or yellowish production of insects, called white lac. Some of this substance, brought from Madras, was analyzed, and found to bear a considerable analogy to bees' wax. The component parts of this acid are carbon, hydrogen, and oxygen.

LACE, in Commerce, a work composed of many threads of gold, silver, or silk, interwoven one with the other, and worked upon a pillow with spindles, according to the pattern designed; the open work being formed with pins, which are placed and displaced as the spindles are moved. For cleaning gold lace and embroidery when tarnished, alkaline liquors are not to be used, for they corrode the silk, and change or discharge its colour. Soap also alters the shade of certain colours. But spirit of wine may be used without any danger of its injuring either the colour or quality; and in many cases proves as effectual for restoring the lustre of the gold, as the corrosive detergents.

LACE *Bone*, a lace made of fine linen, thread, or silk, much in the same manner as that of gold and silver. The pattern of the lace is fixed upon a large round pillow, and pins being stuck into the holes or openings in the pattern, the threads are interwoven by means of a number of bobbins made of bone or ivory, each of which contains a small quantity of fine thread, in such a manner as to make the lace exactly resemble the pattern.

LACERTA, *the Lizard*, was added by Hevelius to the old constellations. *Boundaries and Contents:* north by Cepheus, west by Cygnus, south by Pegasus, and east by Andromeda. In general it lies between Cygnus and Andromeda, and contains sixteen stars, three of the fourth magnitude, the remainder being smaller.

LACHRYMATORY, in antiquity, a vessel wherein were collected the tears of a deceased person's friends, and preserved along with the ashes and urn. They were small glass or earthen bottles, chiefly in the form of phials. At the Roman funerals, the friends of the deceased, or the præficæ, women hired for that purpose, used to fill them with their tears, and deposit them very carefully with the ashes, in testimony of their sorrow, imagining the manes of the deceased were thereby greatly comforted. Many specimens of them are preserved in the cabinets of the curious, particularly in the British Museum.

LACK OF RUPEES, is 100,000 rupees; which, at 2*s.* 6*d.* each, amounts to £12,500 sterling.

LACTATES, combinations of earths and alkalies, &c. with the lactic acid.

LACTATION, among medical writers, denotes the *giving suck*. The mother's breast, if possible, should be allowed the child, at least during the first month; for the child is thus peculiarly benefited by what it sucks, and the mother is preserved from more real inconveniences than the falsely delicate imagine they would suffer by compliance herewith; but if, by reason of an infirm constitution, or other causes, the mother cannot suckle her child, let dry-nursing, under the mother's eye, be pursued.—When women lose their appetite by giving suck, both the children and themselves are thereby injured: wet nurses are to be preferred, who, during the time they give the breast, have rather an increased appetite, and digest more quickly; the former are apt to waste away, and sometimes die consumptive. In short, those nurses with whom lactation may for a while agree, should wean the child as soon as their appetite lessens, their strength seems to fail, or a tendency to hysteric symptoms is manifest.

When the new-born child is to be brought up by the mother's breast, apply it thereto in ten or twelve hours after delivery; thus the milk is sooner and more easily supplied, and there is less hazard of a fever than when the child is not put to it before the milk begins to flow of itself. If the mother does not suckle her child, her breasts should be kept so warm with flannel, or with a hare-skin, that a constant perspiration may be supported; thus there rarely will arise much inconvenience from the milk. The child, notwithstanding all our care in dry nursing, sometimes pines if a breast is not allowed. In this case a wet nurse should be provided; if possible, one that has not been long delivered of a child. She should be young, of a healthy habit, and an active disposition, a mild temper, and with breasts well filled with milk. If the milk is good, it is sweetish to the taste, and totally free from saltness; to the eye it appears thin, and of a bluish cast.

**LACTIC ACID.** By evaporating sour whey to one-eighth, filtering, precipitating with lime-water, and separating the lime by oxalic acid, Scheele obtained an aqueous solution of what he supposed to be a peculiar acid, and called it lactic acid. Bouillon Lagrange has since examined it more narrowly, and concluded it to consist of acetic acid, muriate of potash, a small partion of iron, and animal matter.

**LACTIFEROUS**, an appellation given to plants abounding with a milky juice, as the sowthistle and the like. The name of *lactiferous*, or *lactescent*, is given to all those plants which abound with a thick coloured juice, without regarding whether it is white or not. Most lactiferous plants are poisonous, except those with compound flowers, which are generally of an innocent quality. Of the poisonous lactescent plants the most remarkable are sumach, agaric, maple, burning thorny plant, cassada, celandine, spurge, prickly poppy; and the plants of the natural order contortæ, as swallow-wort, apocynum, cynanchum, and cerbera. The bell-shaped flowers are partly noxious, as cardinal flower; partly innocent, as campanula. Among the lactescent plants with compound flowers, that are innocent in their quality, may be mentioned dandelion, picris, hyoseris, wild lettuce, gum succory, hawkweed, bastard hawkweed, hypochœris, goat's-beard, and most species of lettuce; we say most species, because the prickly species of that genus are said to be of a very virulent and poisonous nature; though Mr. Lightfoot denies this, and affirms, that they are safe and gentle opiates, and that a syrup made from the leaves and stalks is much preferable to the common diacodium.

**LACTOMETER**, the name of an instrument used for the purpose of ascertaining the different qualities of milk, from its specific gravity compared with water, and its degrees of temperature under various circumstances. It was invented by M. Dicas, mathematical instrument maker, of Liverpool, but is yet in its infancy.

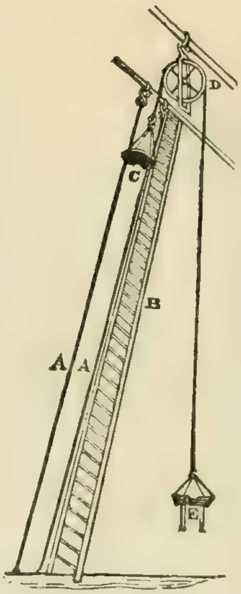
**LACTUCA**, *Lettuce*, a genus of the syngenesia polygamia æqualis class and order of plants. Natural order of compositæ semiflosculosæ. Cichoraceæ Jussieu. There are eleven species; of L. sativa, or common garden lettuce, there are fifteen varieties.

**LACUNAR**, in Architecture, an arched roof or ceiling, more especially the planking or flooring above porticoes or piazzas.

**LADDER**, a well-known convenience, of which there are a great number. In a ship, ladders serve as stairs whereby to ascend or descend from one deck to another; and are distinguished by epithets, according to the several hatchways or other parts of a ship wherein they are situated.

*Scaling* **LADDERS**, in the Military art, are used in scaling when a place is to be taken by surprise. They are made several ways: in England, they are made of flat staves, so that they may move about their pins, and shut like a parallel ruler, for conveniently carrying them: the French make them of several pieces, so as to be joined together, and to be made of any necessary length; sometimes they are made of single ropes, knotted at proper distances, with iron hooks at each end, one to fasten them up the wall above, and the other in the ground; and sometimes they are made with two ropes, and staves between them, to keep the ropes at a proper distance, and to tread upon. When they are used in the action of scaling walls, they ought to be rather too long than too short, and to be given in charge only to the stoutest of the detachment.

*Thompson's Mechanical* **LADDER.**—This ladder is a very ingenious contrivance, invented by a gentleman of the name of Thompson, and called by him the mechanical ladder. A A in the accompanying sketch, denote parallel ropes stretched and placed for the purpose of steadily conducting a seat or carriage C, in which a man may sit, and descend from the upper to the lower points of A A; these lines may be placed either in a perpendicular or inclined position; but an inclined position, forming an angle of about twenty degrees with the perpendicular, will in general be found most eligible. The carriage C may be connected by ropes, by rings, loops, or any kind of bearing parts which will confine it to a regular ascent and descent. It is connected with the counterpoise or place of reaction, E, by a rope passing over the pulley D. B B represents a ladder for the workmen to ascend.



The manner of working this machine is as follows: the workman ascends by B B, and places himself in the carriage C, in which his weight (by preference) forms nearly an equilibrium with the weight E, which may, for example, be imagined a basket of coals. Either by taking hold of the leading ropes, or of a rope passing downwards for that purpose, he causes the carriage to descend briskly, which at the same time brings up E. He then quits the carriage, and at that time, E (which we may suppose to have been emptied by another assistant by reversing it (or otherwise) being somewhat heavier than C, descends again, and raises C to its first situation, and by the time E is again filled, the workman is ready at the top of the ladder, where he enters the carriage, and raises a second load; and in this way the work may be continued at pleasure. It is evident that this work may be performed by two or more workmen ascending and descending in succession by means of the same ladder; or, if more convenient, by more ladders than one, and in case it should be desired to lift the body E through a greater space than is to be ascended by the workmen upon B B, the purpose may be effected by fixing D higher, and causing two carriages to descend in succession along the ropes A A, though this plan is not particularly to be recommended.

The rope D E may also be wound on a barrel, and the rope D C on another, or similar barrel, both on the same axis. The parts of the machine A A, may instead of ropes be wooden or metallic sliders.

This machinery, the inventor observes, is applicable to drawing, driving, forcing, impressing, or moving bodies of every description, and that in such applications of it, no other variations in the construction, connexion, or method of working it, will be needful, than such as any person possessing an ordinary acquaintance with mechanical operations, may execute with facility.

The vulgar objection to the plan is ascending the ladder, yet this is its chief recommendation, for it is the easiest method of raising a weight. The truth of this assertion will be ascertained from the following statement.

If it be required to raise a sack of corn, a basket of coals, or any other equal weight, to the height of forty feet, (more or less) no method can be so easy to the person who is to raise the weight, as to ascend stairs or a ladder unencumbered, and to raise the sack, &c. by his own weight. By no other exertion of his own, nor by the assistance of any mechanical powers, can he perform the same operation in the same time. It must consequently be the easiest mode of raising a weight, or it could not be done in the shortest time. If it is easier in one operation, it must be equally so in any number of operations. If it is easier for one man, it must be equally so where any number of men can be employed to work together in raising heavy weights, and where this principle can be introduced. If it is easier, it must be cheaper. The labour consists in ascending the ladder, and in this exertion the man's muscular powers are all in action at the same time; not partially used, as in most other modes of raising weights. His strength may be combined with his gravity in his descent, and if opposed by the least possible friction, he cannot work with greater advantage.

Desaguliers states the maximum of a man's power as under: One man 500 pounds, 12 feet, 1 minute. The weight raised was water in a bucket. The man, who was very powerful, ascended stairs with a weight about his own person, which, together with his own, was equal to the water, and placed himself on or in an empty bucket, which was suspended by a rope passing over a pulley, and fastened to the bucket containing the water below, and raised it in the time. The man was so exhausted, that he could not repeat the operation.

The following experiment has often been exhibited by means of the present invention. One man, 1500 pounds, 12 feet, 1 minute. And this difference arises from the man's strength being combined with his gravity, and the facilities which the two parallel ropes afford him, to gain velocity by a slight exertion of his arms to arrest his descent, and quickly to re-ascend the ladder. If a man weighs 14 stone, or 196 pounds, and ascends the ladder eight times in a minute (which almost any active man may do) it is clear that he can raise eight times his own weight, or 1568 pounds.

The steps of the ladder being one foot apart (that stride being found most agreeable to the labourers) if a man ascends as slowly as possible, that is, at the rate of one foot in each second, he will ascend five times in a minute to the height of twelve feet; and if he weighs twelve stone, or 168 pounds (the average weight of a labouring man) he will raise his weight five times, or 840 pounds in that time. He will probably consume ten seconds in ascending, and one or two seconds in descending and raising the weight. He cannot work slower. Applying this rate of work, the result of one man's power for one hour in raising the under-mentioned articles will be,

| | | |
|---|---|---|
| Coals, ...................... | 10 chaldrons | 20 feet. |
| Malt, Barley, Oats, &c. ...... | 90 quarters | 20 feet. |
| Bricks, ...................... | 6000 quarters | 20 feet. |
| Water, ...................... | 3000 gallons | 20 feet. |

When the distance is doubled, the weight raised during the same time, will be one half.—The following weights have already been raised:

| | Men. | Feet. | Hours. | Min. |
|---|---|---|---|---|
| Coals* 240 chaldrons, ...... | 2 | 6½ to 21 | 17 | 7 |
| Bricks† 22,000 ........... | 2 | 40 .... | 7 | 30 |
| Ditto, 6000 ............... | 2 | 40 .... | 1 | 0 |
| Ditto, 1500 ............... | 2 | 40 .... | 0 | 12 |

There are four men employed to raise a basket of coals on the river Thames, and six on many parts of the coast. It has hitherto (in 1810) been found impossible to establish, or even try this plan on board of any collier in the river Thames; but it has been used at Brighton, where one of Lathmar's ships was discharged by it, with four men short of the usual complement, and in rather less than the usual time; only four men being employed to work in the hold, they could not fill the basket faster, or the vessel would have been discharged in half the usual time. The two men who worked the machine, waited nearly half of the time for a supply, and could have raised 20 chaldrons per hour instead of 12, the quantity with which they were supplied.

This plan has for a considerable time been established at the East India Docks, where all the Indiamen are discharged by it. The first ship on board of which it was tried, was the Fort William, laden with bales of cotton, weighing about two hundred and three-quarters each. The bales were raised by two men only. The Porcher was delivered at the same time by the old plan, and contained a similar cargo; each bale was raised by six men. From the Fort William 5532 bales were delivered in 17 days; from the Porcher, 5022 in 20 days; leaving an advantage of four men, three days, and a surplus of 510 bales in favour of the Fort William. The men who raised the bales on board the Fort William stood still nearly half the time, as the weigher could not pass the bales quicker through the scales. The men who raised the bales from the Porcher were fully employed, and exerted themselves to the utmost, with the hope of preventing the establishment of the new plan.

The inventor of this machine took out a patent for it, the specification of which is dated March 20, 1809. He offered the use of his invention to the City of London, without the reservation of any remuneration to himself, stipulating only that a part of the saving arising from it might be devoted to a fund for bettering the present and future condition of the men, to whose labours it was chiefly applicable; so as eventually to establish some asylum or provision for them and their families, when age or accident might have disabled them from working.

The advantages derivable from the machine, were confirmed before Sir Charles Flower, the Lord Mayor in 1809, by the affidavits of two men who used it; by which it appeared that they had actually been able to perform with it more work than had ever been done by any four men in the same time. The inventor, in his memorial to the Lord Mayor and Court of Aldermen, observes, "that any man may work by his plan, no drilling being required; and as it is merely an improvement of the old principle, it should not be regarded as the substitution of any other power for that of man, as steam, horse-power, &c."

The foregoing statements we have extracted from a very useful work in two volumes, called "The Mechanic, or Compendium of Practical Inventions," in which a description of a great number of very useful inventions may be found.

**LADEN**, the state of a ship when she is charged with a weight or quantity of materials equal to her tonnage or burden. If the goods, with which she is laden, be extremely heavy, her burden is determined by the weight thereof; but if light, she carries as much as she can stow, for the purposes of navigation. As a ton measure is generally estimated at 2000lbs in weight, a vessel of 200 tons ought accordingly to carry a weight equal to 400,000 pounds; therefore, when the matter of which the cargo is composed is specifically heavier than the water in which she floats,—or, in other words, when the cargo is so heavy that she cannot float high enough with so great a quantity of it as her hold will contain,—a diminution thereof becomes absolutely necessary.

**LADY.** This title is derived from two Saxon words, which words have in time been contracted into the present appellation. It properly belongs only to the daughters of earls, and all of higher rank; but custom has made it a word of complaisance for the wives of knights, and of all eminent women.

**LÆTIA**, a genus of plants belonging to the polyandria class, and in the natural method ranking with those of which the order is doubtful.

**LAGURUS**, a genus of plants belonging to the triandria class, and in the natural method ranking under the fourth order, gramina.

**LAITY**, the people, as distinguished from the clergy; *see* Clergy. The lay part of his majesty's subjects is divided into three distinct states; the civil, the military, and the maritime. *See* Civil, Military, and Maritime.

**LAKE**, a collection of waters which usually receives and discharges rivers. Of lakes, which both receive and emit rivers, we reckon three kinds, as the quantity they emit is greater, equal, or less than they receive. If it be greater, it is plain that they must be supplied by springs at the bottom; if less, the surplus of the water is probably spent in exhalation; and if it be equal, their springs just supply what is evaporated by the sun. Lakes are also divided into those of fresh water, and those of salt. Large lakes answer the most valuable purposes in the northern regions.

**LALANDE**, Joseph Jerome Le Francais, a celebrated French astronomer, was born at Bourg, in the department of L'Ain, in July, 1732. He was first intended for the bar, but his genius having been very early directed to astronomical subjects, his first intention was given up; and he followed his astronomical pursuits under the celebrated Lemonier, with the greatest success. Lalande was also an associate of the principal learned societies in Europe, and was for many years the centre of communication amongst the most celebrated of their members. After a long and useful life in the pursuit of science, he died on the fourth of April, 1807, being then in the 75th year of his age.

**LAMA**, the sovereign pontiff, or rather god, of the Asiatic Tartars.

**LAMB**, The Barometz, or Tartarian.—Whoever has perused the accounts of early travellers, must recollect the stories that have been copied into our ancient herbals, of Tartarian sheep growing upon stems in the earth, and thence devouring all the vegetables that came within their reach.

A tale of this kind could not fail to attract the attention of the immortal father of modern botany, who took considerable pains to investigate it, and ascertained that, in the eastern part of Chinese Tartary, there is a species of fern furnished with thick tubers, which being surrounded on all sides with yellow wool, and thin chaffy scales, are often raised so high above the ground, that the roots beneath bear some resemblance to legs fixed in the soil.

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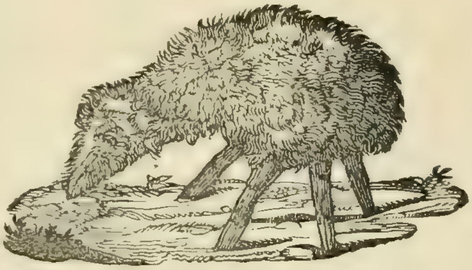
* The coals in baskets similar to those used on the river Thames.

† The bricks, two hods, or about 34 at a time.



The genus of this fern has not yet been ascertained, but it is known that the roots spread round to a considerable extent, and perhaps prevent all other plants growing near it: it is not at all surprising that the imagination of the superstitious and ignorant should transform this curious vegetable into a *voracious sheep*. A specimen of such botanical curiosity could not pass unnoticed by the observant but romantic Darwin; and accordingly we find him speaking of it in the following terms.

> E'en round the pole the flames of love inspire,
> And icy bosoms feel the secret fire!
> Cradled in snow, and fanned by arctic air,
> Thine, gentle *Barometz!* thy golden hair;
> Rooted in earth each cloven foot descends,
> And round and round her flexile neck she bends;
> Crops the gray coral moss, and hoary thyme,
> Or laps with rosy tongue the melting rime,
> Eyes with mute tenderness her distant dam,
> Or seems to bleat, a *vegetable lamb*.

**LAMBERT**, John Henry, an eminent mathematician and astronomer, was born at Muhlhausen in Sundgaw, belonging to Switzerland, Aug. 29, 1728. His parents being poor, he had great difficulties to contend with in the pursuit of his studies, which he nevertheless prosecuted with unbounded success. Most of his mathematical pieces were published in a collected form by himself, in three volumes, in which almost every branch of mathematical science has been enriched with his improvements and additions. Lambert died in 1777, in the 50th year of his age.

**LAMINÆ**, in Physics, are extremely thin plates, of which solid bodies are supposed to be made up. These are indeed rather ideal than real; but such a conformation is frequently supposed, for the sake of simplifying the solution in a great variety of physical problems.

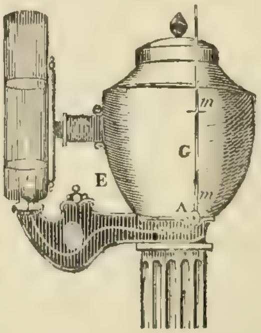
**LAMMAS Day**, the first of August, so called, as some will have it, because lambs grow out of season, as being too big. Others derive it from a Saxon word, signifying "loaf-mass," because on that day our forefathers made an offering of bread made with new wheat. On this day, the tenants who formerly held lands of the cathedral church in York, were bound by their tenure to bring a lamb alive into the church at high mass.

**LAMP**, a vessel containing oil, with a lighted wick. From experiments made in order to ascertain the expense of burning chamber oil in lamps, it appears, that a taper lamp, with eight threads of cotton in the wick, consumes in one hour $\frac{325}{1000}$ oz. of spermaceti oil at 2*s.* 6*d.* per gallon; so that the expense of burning 12 hours is 4·57 farthings. This lamp gives as good a light as the candles of eight and ten in the pound; it seldom wants snuffing, and casts a strong and steady light. A taper, chamber, or watch lamp, with four ordinary threads of cotton in the wick, consumes 0·1664 oz. of spermaceti oil in one hour; the oil, at 2*s.* 6*d.* per gallon, makes the expense of burning 12 hours only 2·34 farthings. Of lamps there are many constructions; a few of the most remarkable, yet useful, are :—

*Argand's* Lamp. This is a very ingenious contrivance, and the greatest improvement in lamps that has yet been made. It is the invention of a citizen of Geneva; and the principle on which the superiority of the lamp depends, is the admission of a larger quantity of air to the flame than can be done in the common way. This is accomplished by making the wick of a circular form, by which means a current of air rushes through the cylinder on which it is placed with great force; and, along with that which has access to the outside, exciting the flame to such a degree that the smoke is entirely consumed. Thus both the light and heat are prodigiously increased, at the same time that there is considerable saving in the expense of oil, the combustion being exceedingly augmented by the quantity of air admitted to the flame; and that what in common lamps is dissipated in smoke, is here converted into a brilliant flame.

This lamp is now very much in use, and is applied not only to the ordinary purposes of illumination, but also to that of a lamp furnace for chemical operations, in which it is found to exceed every other contrivance yet invented. It consists of two parts, *viz.* a reservoir for the oil, and the lamp itself. The reservoir is usually in the form of a vase, and has the lamp proceeding from its side. The latter consists of an upright metallic tube, about one inch and six-tenths in diameter, three inches in length, and open at both ends. Within this is another tube about an inch in diameter, and nearly of an equal length; the space betwixt the two being left clear for the passage of the air. The internal tube is closed at the bottom, and contains another similar tube about half an inch in diameter, which is soldered to the bottom of the second. It is perforated throughout, so as to admit a current of air to pass through it; and the oil is contained in the space betwixt the tube and that which surrounds it. A particular kind of cotton cloth is used for the wick, the longitudinal threads of which are much thicker than the others, and which nearly fill the space into which the oil flows; and the mechanism of the lamp is such, that the wick may be raised or depressed at pleasure. When the lamp is lighted, the flame is in the form of a hollow cylinder; and by reason of the strong influx of air through the heated metallic tube, becomes extremely bright, the smoke being entirely consumed, for the reason already mentioned. The heat and light are still farther increased, by putting over the whole a glass cylinder nearly of the size of the exterior tube. By diminishing the central aperture, the heat and light are proportionably diminished, and the lamp begins to smoke. The access of air, both to the external and internal surfaces of the flame, is indeed so very necessary, that a sensible difference is perceived when the hand is held even at the distance of an inch below the lower aperture of the cylinder; and there is also a certain length of wick at which the effect of the lamp is strongest. If the wick be very short, the flame, though white and brilliant, emits a disagreeable and pale kind of light; and if very long, the upper part becomes brown, and smoke is emitted.

The *Ball Cock*, or *Self-regulating* Lamp. The principle of this lamp is that of the ball-cock. The manner in which it operates will be immediately understood from a slight consideration of the annexed figure of it, in which the several parts are represented in the situations which they respectively assume when the reservoir is empty. Those parts only are noticed which are necessary to explain the manner in which the lamp regulates itself.



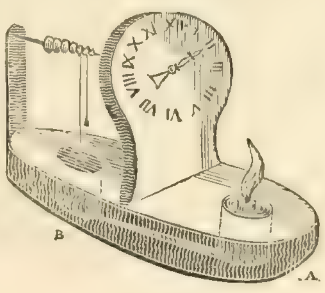
A is a valve at the bottom of the reservoir, to which is attached an upright stem G, moveable vertically through holes in the projecting pieces of metal *m m*. To this is attached the ball, an air-tight vessel of a globular form, and so light as to float in oil, (a piece of varnished cork might be substituted.) A bent wire, moveable about as a centre, has one of its ends soldered to the ball, and the other is in contact with the valve A. E is the burner, with its socket, wick, &c. A lid covers the chamber enclosing the ball float, and which may be removed when necessary for the purpose of cleaning the inside. While the parts of the lamp are in the situation just described, let oil be poured into the reservoir. It is manifest, that it will flow through the aperture at the bottom into the chamber containing the hollow ball, which will in consequence float, and be caused to ascend. Hence the opposite extremity of the bent wire will descend, and the valve *A* will follow it by its own gravity, closing the aperture, and preventing the further efflux of oil. As, however, the oil is gradually consumed in the burner, it is manifest that the ball will descend, and consequently elevate the opposite extremity of the wire, together with the valve A, thus producing a fresh efflux of oil, until the whole is consumed. This lamp moreover keeps the surface of the oil in the burner always very nearly at the same distance from the flame; it projects no shadow from itself, and may be supplied with oil while burning.

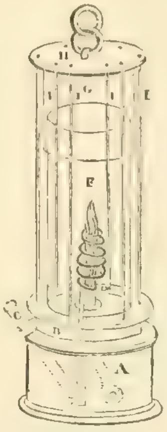
*Hydro-Pneumatic* Lamp. The discovery of M. Dobereiner of the remarkable action of spungy platinum upon hydrogen gas, has led to the construction of an elegant lamp for producing instantaneous light. This lamp was, we believe, first made for sale by Mr. Garden, of London; but it has since been improved form by Mr. Adie, optician, in Edinburgh.—[*See* Plate, Malt-kilns and Lamps.]

The form given to the lamp by Mr. Garden, is shewn in the plate, fig. 3, where A B is a glass globe, fitting tightly by a ground shoulder into the neck *m n*, of another globe or vessel C D. The globe A B terminates downwards in a hollow neck, *m n o p*, in the lower end of which is placed a small cylinder of zinc *o p*. Into the neck of the vessel C D is fitted a brass piece *a b c*, through which the gas contained in C D can escape at the point *c*, by turning a cock *d*. An arm *e f* slides through *h*, and carries in a brass box P a piece of spungy platinum, which can be brought nearer to *c*, or removed from it, by sliding the arm *e f* through *h*. If we now pour diluted sulphuric acid into the vessel A B by the mouth at S, it will descend through the neck *m n*, compressing the air in C D, if the cock *d* is shut. The diluted acid will now act upon the ring of platinum, *o p*, and produce hydrogen gas, which, after the common air in C D is let off, will gradually fill the vessel C D. When the gas is thus collected in the vessel C D, a stream of it may at any time be discharged through the aperture C, and thrown upon the spungy platinum P, when it will produce such an intense heat as to make the platinum red-hot, and thus afford an instantaneous light. In Mr. Garden's lamp, the ring of zinc *o p*, floats upon a piece of cork, so that when the vessel C D is filled with gas, the diluted acid does not touch the zinc, and consequently no more hydrogen gas is produced; but the moment any of the gas is let off at *c*, the pressure of the head of fluid in A B overcomes the elasticity of the remaining gas in C D, and the diluted acid is forced up to the zinc, to reproduce the wasted hydrogen. By this ingenious contrivance, the diluted acid is pressed up against the zinc when more hydrogen is wanted, and withdrawn from it when the vessel C D is full. The form given to the lamp by Mr. Adie, of Edinburgh, is shewn in fig. 4, where the different parts are marked by the same letters as in fig. 3. In this construction, a cone of glass, *k*, formed on the bottom of the vessel A B, is made to hold the ring of zinc, *o p*, which remains permanently in that position.

This lamp has the advantage of greater stability, and is less liable than the other to be deranged by an accidental cause. Professor Cumming, of Cambridge, who constructed one of these lamps in December 1823, found it necessary to cover up the platina with a test tube, or a cap, after every experiment. With platina foil $\frac{1}{9567}$ of an inch in thickness, and kept in a close tube, he produced the same effect; but when the thickness of the foil was $\frac{1}{6440}$, it was necessary to raise it previously to a red heat. These lamps, besides their extreme beauty as philosophical toys, are of great use in counting-houses, as well as in private houses, in summer.

*Peck's Clock* Lamp. To those who are in the habit of burning a light during the night, Peck's dial lamp may prove an acceptable companion. A B are two vessels made of tin, about $1\frac{1}{2}$ inch diameter, and the same in depth, communicating at the bottom by a small tube. In A burns a floating wick; in B, a float balanced over a cone-like rool, by a small weight hanging on a piece of fine silk; the rool should contain several grooves, and vary in diameter from $\frac{1}{4}$ to $\frac{1}{2}$ inch. The gradual burning of the oil in A, will cause the float B to fall, thereby turning the rool, which being affixed on a wire communicating with the index through the dial, will point out the hour of the night. It is necessary to adjust the index to the true time when the lamp is lighted; and some little attention is requisite to place the silk in the proper groove on the rool, which acts as a regulator to quicken or retard the burning of the oil.—*Mech. Mag.* 1825.





The *Safety* Lamp, invented by Sir H. Davy, to secure miners from the destructive effects of the choke damp and the fire damp; the former consists, for the most part, of carbonic acid gas, hovers about the lower parts of the mine, and extinguishes their lights; and the latter, which is simply hydrogen gas, occupies the superior spaces, and involves incalculable mischief, from the combustion produced by its contact with the flame of the miners' candles.

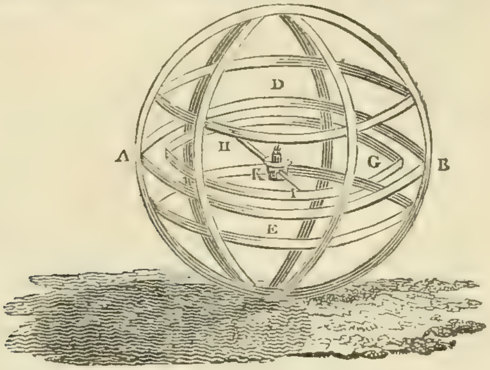
The parts of the lamp are,—A, the brass cistern which contains the oil, pierced near the centre with a vertical narrow tube E, nearly filled with a wire which is recurved above, in the level of the burner, to trim the wick, by acting on the lower end of the wire, with the fingers: it is called the safety trimmer. B, the rim in which the wire-gauze cover is fixed, and which is fastened to the cistern by a moveable screw. C, an aperture for supplying oil, fitted with a screw or cork, and which communicates with the bottom of the cistern by a tube; and a central aperture for the wick. D, the burner, or receptacle for the wick, over which is fixed the coil of platinum wire. F, the wire gauze cylinder, which should have not less than 625 apertures to the square inch. G, the second top, $\frac{3}{4}$ of an inch above the first, surmounted by a brass or copper plate, to which the rings of suspension are fixed. I, I, I, six thick vertical wires, joining the cistern below to the top plate, and serving as protecting and strengthening pillars round the cage.

When the wire gauze safety-lamp is lighted, and introduced into an atmosphere gradually mixed with fire-damp, the first effect of the fire-damp is to increase the length and size of the flame. When the inflammable gas forms as much as 1-12th of the volume of the air, the cylinder becomes filled with a feeble blue flame, but the flame of the wick appears burning brightly within the blue flame, and the light of the wick augments till the fire-damp increases to $\frac{1}{8}$ or $\frac{1}{4}$, when it is lost in the flame of the fire-damp: which in this case fills the cylinder with a pretty strong light. As long as any *explosive* mixture of gas exists in contact with the lamp, so long it will give light; and when it is extinguished, which happens when the foul air constitutes as much as $\frac{1}{3}$ of the volume of the atmosphere, the air is no longer proper for respiration; for though animal life will continue where flame is extinguished, yet it is always with suffering. By fixing a coil of platinum wire above the wick, ignition will continue in the metal when the lamp is itself extinguished; and from the ignited wire the wick may be again re-kindled, on going into a less inflammable atmosphere.

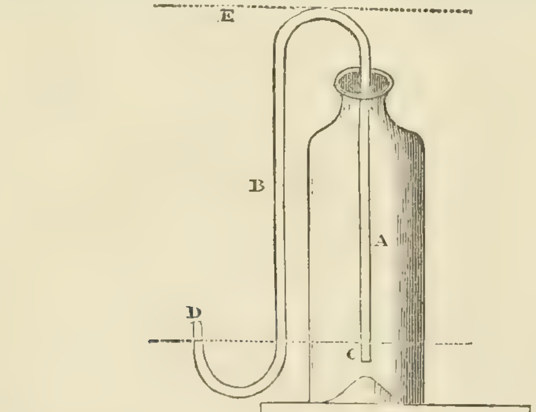
Wherever workmen, however, are exposed to such highly explosive mixtures, double gauze lamps should be used; or a lamp in which the circulation of the air is diminished by a tin-plate reflector placed in the inside; or a cylinder of glass, reaching as high as the double wire, with an aperture in the inside; or slips of Muscovy glass may be placed within the lamp; and, in this way, the quantity of fire-damp consumed, and consequently of heat produced, may be diminished to any extent. Such lamps, likewise, may be more easily cleaned than the simple wire-gauze lamps; for the smoke may be wiped off in an instant from the tin plate or glass.

If a blower or strong current of fire-damp is to be approached, double gauze lamps, or lamps in which the circulation of the air is interrupted by slips of metal or glass, should be used; or if the single lamp be employed, it should be put into a common horn or glass lantern, the door of which may be removed or open. Another improvement has recently been made, by which its utility will be greatly increased. It consists in attaching a convex lens to the lower part of the wire gauze, which enables the miner to direct a strong light upon any particular part of the mine.

The *Rolling* Lamp,—Is easily constructed: A B we will suppose is a machine with two moveable circles, D E, F G, within it, whose common centre of motion and gravity is at K, where their axes of motion cross one another. If the lamp K C is made pretty heavy, and moveable about its axis H I, and whose centre of gravity below K is fitted within the inner cricle, the common centre of gravity of the whole machine will fall below K, and by reason of the pivots A, B, D, E, H, I, will be always at liberty to descend; hence, though the whole machine be rolled along the table, or moved in any manner, the flame will always be uppermost, and the oil cannot be spilled. The lamp may be a handsome brass or gilded ball, and the whole effect would be delightful.



The *Syphon* Lamp, an original invention, the description of which appeared some time ago in the London Mechanic's Register. A is a bottle containing oil. B a syphon, one end of which nearly touches the bottom of the bottle; and which end must be half an inch farther from the parallel line E, than the end D is from the same line. By sucking out the air at D, the oil will follow it copiously; but by drawing up the syphon (which, by a spring, introduced into the neck of the bottle, is made to remain at any height,) till the end C is only a quarter of an inch in the oil, the end D will be empty a quarter of an inch down; into which put a piece of cotton, fitting rather tightly, and after cutting it off flat, at rather more than the eighth of an inch from the tube, push down the syphon, ignite the cotton, and this syphon lamp will give a light of a very superior clearness; which is to be attributed to the *pressing* supply of oil at the bottom of the cotton. Moreover, it is a very economical lamp. The bottle and the piece of tube, which any one can bend into a syphon, cost next to nothing; and the superior brilliancy of the flame renders it unnecessary that it should be half the usual size, and consequently a little more than half the usual quantity of oil is consumed.



LAMPÆDIAS, a term sometimes applied to denote a bearded comet.

LAMPBLACK. The finest lamp black is produced by collecting the smoke from a lamp with a long wick, which supplies more oil than can be perfectly consumed; or by suffering the flame to play against a metalline cover, which impedes the combustion, not only by conducting off part of the heat, but by obstructing the current of air. Lampblack, however, is prepared in a much cheaper way, for the demands of trade. The dregs which remain after the eliquation of pitch, or else small pieces of fir wood, are burned in furnaces of a peculiar construction, the smoke of which is made to pass through a long horizontal flue, terminating in a close-boarded chamber. The roof of this chamber is made of coarse cloth, through which the current of air escapes, while the soot remains behind.

LAMPYRIS, in Natural History, *Fire Fly*, a genus of insects of the order of coleoptera. There are nearly sixty species. The common glow worm is seen during the summer months, on dry banks about woods and pastures, exhibiting, as soon as it is dusk, vivid and phosphoric splendour in form of a round spot, of considerable size. The animal itself, which is the female insect, measures about three-quarters of an inch in length, and is of a dull earthy-brown colour on the upper parts, and beneath more or less tinged with rose-colour, with the two or three last joints on the body of a pale or whitish sulphur colour. It is from these parts that the phosphoric light proceeds. The male is smaller than the female, and is provided with wings and wing-sheaths: it is not determined whether it be luminous or not.

LANA Philosophica, (philosophical wool,) the snowy flakes of white oxide, which rise and float in the air from the combustion of zinc.

LANCE, a spear, or offensive weapon, borne by the ancient Cavaliers, in the form of a half pike. The lance consists of three parts; the shaft, the wings, and the dart. It is among the oldest weapons recorded in history. The invention of gunpowder has rendered this instrument of destruction less important than it was in ancient times.

LANCET, a chirurgical instrument, sharp-pointed and two-edged, chiefly used to open veins in the operation of phlebotomy, or bleeding; also for laying open abscesses, tumours, &c.

LAND, as applied to the earth generally. The constituent parts of the earth are two, the *land* and *water*. The parts of the land are continents, islands, peninsulas, isthmuses, promontories, capes, coasts, mountains, &c. This land is divided into two great continents, (besides the islands,) *viz.* the *eastern* and *western* continent. The eastern is subdivided into three parts, *viz.* Europe, on the north-west; Asia, on the north-east; and Africa (which is joined to Asia by the isthmus of Suez, 60 miles over) on the south. The western continent consists of North and South America, joined by the isthmus of Darien, 60 or 70 miles broad. A *Continent* is a large portion of land, containing several countries or kingdoms, without any entire separation of its parts by water, as Europe. An *Island* is a smaller part of land, quite surrounded by water, as Great Britain. A *Peninsula* is a tract of land every where surrounded by water, except at one narrow neck, by which it joins the neighbouring continent; as the Morea in Greece; and that neck of land which so joins it, is called an *Isthmus:* as the isthmus of Suez, which joins Africa to Asia; and the isthmus of Darien, which joins North and South America. A *Promontory* is a hill, or point of land, stretching itself into the sea, the end of which is called a *Cape;* as the Cape of Good Hope. A *Coast* or *Shore* is that part of a country which borders on the sea-side. Mountains, valleys, woods, deserts, plains, &c. need no description.

Land *Measuring.*—Land is commonly measured by means of the chain and its accompaniments. The Scotch chain is 24 Scotch ells, or 74·138 English feet in length, each link being 8·89656 inches; and the English chain is 22 yards, or 66 feet in length, each link being 7·92 inches. The chain should be accompanied with

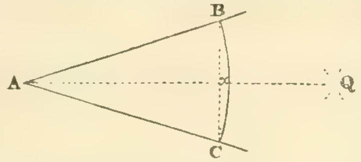
1st. Ten small iron arrows, from 12 to 20 inches in length, for sticking into the ground at the end of every chain's length; each arrow having a piece of red cloth fastened to its head, that it may be the more easily observed. 2. Three or four picket staves, from 6 to 10 feet in length, and shod with iron, for sticking into the ground at corners, &c. to direct the sight; each staff having a red or white flag at its top, that it may be seen when placed at a distance. 3. A tape, (such as is used by artificers for measuring their work,) divided into links instead of feet, for measuring offsets, or short distances between the chain-line and the boundary of the field. 4. A cross staff, for setting off the offsets at right angles to the chain line. The cross staff may be constructed thus: Take a thick circular board of well-seasoned hard wood, about 4 inches in diameter, on which draw two straight lines cutting each other at right angles; saw these lines across about half an inch deep, and one-sixteenth of an inch wide. To this board, by means of a socket, fasten a staff shod with iron for sticking into the ground.

The dimensions of any piece of ground may be accurately ascertained by these instruments; but for greater ease and despatch, surveyors generally employ some instrument for observing angles. For that purpose, the most proper instrument is a *theodolite*, furnished with two achromatic telescopes, the different adjustments and rack-work motions, parallel plates, compass, level, &c.

The *plane table* also is often of great use in land measuring, as it affords the means of plotting on the spot, the ground as it is measured, and of detecting any errors which may be committed in the work.

*Problem* 1.—*To measure a horizontal angle (as* B A C, fig. 1,*) by means of the chain.*—Rule. Measure any distance, as 100 links from A to B, and there stick an arrow into the ground; measure the same distance from A to C, and there also place an arrow; then measure the distance from B to C; thus will the three sides of the isosceles triangle B A C be known; whence the angle A may be found thus:—Draw the perpendicular A $x$, and the point $x$ will be in the middle of B C. Then, A B : B $x$ : : rad : S B A $x$; or if B $x$ be reduced to 1000 parts of A B, it will be = the natural sine of B A $x$, which being doubled, will give B A C, the angle required.

*Fig.* 1.

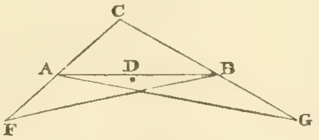


*Example.*—Let A B or A C be 1 chain, and B C 76·7 links, what is the angle B A C?

·767 ÷ 2 = ·3835 = Nat. sine of 22° 33′, which being doubled is = 45° ·6′. = B A C. Answer.

*Problem* 2.—*To measure a triangular field, (as* A B C, fig. 2.*)* Rule. Measure the three sides with the chain; or measure the base A B and the perpendicular D C; or measure any two sides and the included angle; or measure one side, and the two adjacent angles: by adopting any of these methods, sufficient data will be obtained for constructing the figure, and ascertaining its content.

*Fig.* 2.



*Example.*—What is the area of a triangular field, the three sides of which are 806 links, 400 links, and 810 links?

*Operation.*

$$\begin{array}{rrcl@{\qquad}rcrrrl}
810 & 198 & = & 2{\cdot}2966652 & 1{\cdot}56563 & = & \overset{\text{A.}}{1} & \overset{\text{R.}}{2} & \overset{\text{F.}}{10} & \overset{\text{E.}}{18}\ \textit{Ans.} \\
806 & 202 & = & 2{\cdot}3053524 & 4 & & & & & \\
400 & 608 & = & 2{\cdot}7839036 & \overline{2{\cdot}26252} & & & & & \\
\overline{2)2016} & & & & 40 & & & & & \\
1008 & & = & 2{\cdot}0034605 & \overline{10{\cdot}5008} & & & & & \\
 & & 2) & \overline{10{\cdot}3893807} & 36 & & & & & \\
156563 & & = & 5{\cdot}1946903 & \overline{18{\cdot}0288} & & & & &
\end{array}$$

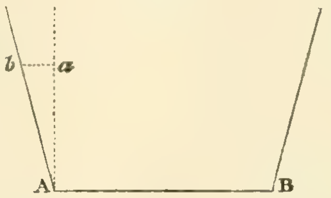
*Observations.* The distances are always expressed in links, and not in chains and decimals; the content therefore is found in square links; from the right of which, five figures being cu off for decimals, the rest will be acres, and the decimal being valued, will give the roods, falls, &c.

2. The method of measuring lines with the chain is as follows:—A picket staff being stuck into the ground in the direction of the line to be measured, (if there do not appear some mark naturally in that direction,) the assistant takes the end of the chain in one hand, and the ten arrows in the other, and proceeds forward towards the staff, the master measurer, or hindermost chainman, who has the other end of the chain in his hand, standing at the beginning of the line. When the assistant has gone to the end of the chain's length, he is directed in his position by the follower waving his hand to the right or left, till the follower see him exactly in a line with the mark to be measured to; there both of them stretching the chain straight on the ground, the leader sticks an arrow into the ground at the end of it, as a mark for the follower to come up to, and advances forward another chain, being directed in his position as before; the chain being then stretched, he sticks down an arrow at the end of it, and the follower takes up his arrow. They then advance in the same manner another chain's length; and thus they proceed till all the ten arrows are in the hands of the follower, and the leader without an arrow is arrived at the end of the eleventh chain's length. The ten arrows are then conveyed to the leader, who puts down one of them at the end of his chain, and advances with the chain as before. Thus the arrows are changed from the one to the other at every ten chains length; by this means the length of the line is easily ascertained: thus, if the arrows have been twice changed, and the follower hold four arrows, and the end of the line cut off 37 links more, the whole length of the line is 2437 links.

3. The method of raising perpendiculars on the ground by means of the cross staff is as follows:—When in measuring along A B (fig. 2,) you come to about D, where you judge the perpendicular will stand, plant the cross staff there, and look through one of the slits in the direction of the chain line; then, if on looking through the other slit, it points directly to C, the place of D is right; if not, move the instrument towards B or A, till it do so; thus the point D may be accurately found.

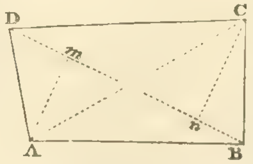
4. The method of measuring horizontal angles by the cross staff is as follows:—Suppose the obtuse angle, B A $d$, (fig. 3,) were required. Plant the cross staff at A, and look through one of the slits in the direction of B, then look through the other slit, having previously sent an assistant forward a few chains with a pole to be stuck into the ground at $a$; measure A $a$, then remove the cross staff to $a$, placing a pole in its stead at A. Look through one of the slits to the pole at A, and then through the other slit to $b$, and measure $a$ $b$. Then A $a$ : $a$ $b$ : : Rad : T, $a$ A $b$, which being added to 90° gives B A $d$, the angle required. Again, let the acute angle A (fig. 2,) be required. Plant the cross staff at any convenient point in A B as D, and measure A D; look through one of the slits in the direction of A, then look through the other slit, and make a pole be placed at C, where the perpendicular meets A C; measure D C. Then A D : D C : : Rad : TA, the angle required.

*Fig.* 3.



*Problem* 3.—*To measure a four-sided field,* (fig. 4.)—Rule. Measure the sides and a diagonal; or measure a diagonal and the two perpendiculars; or measure the sides and one of the angles; or measure the diagonals and the angle of intersection; or measure a diagonal as A C, and the angles C A B, C A D, A C B, A C D; or measure the distance of a point within the field from each of its corners, and the angles at that point subtended by the sides of the field: any of these methods will afford sufficient data for planning the field, and determining its area.

*Fig.* 4.



*Example.*—If A B = 598, B C = 439, C D = 657, D A = 320, and A C = 779 links, what is the area of the field A B C D?

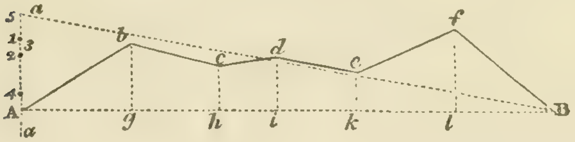
| *Operation* 1.—*To find the area of* A B C. | 2. *To find the area of* A C D. |
|---|---|
| 439 } 469 = 2·6711728 | 779 } 99 = 1·9956352 |
| 598 } 310 = 2·4913617 | 657 } 221 = 2·3443923 |
| 779 } 129 = 2·1105897 | 320 } 558 = 2·7466342 |
| 2)1816 | 2)1756 |
| 908 .... = 2·9580858 | 878 .... = 2·9434945 |
| 2)10 2312100 | 2)10 0301562 |
| 130498 = 5·1156050 | 103532 = 5·0150781 |

*Area of* A B C = 130498
*Area of* A C D = 103532

| | | A. | R. | F. | |
|---|---|---|---|---|---|
| *Area of* ABCD = 2·34030 | | 2 | 1 | 14 | *Ans.* |

*Problem* 4.—*To measure offsets*, (fig. 5.)—Rule. Let A, *b*, *c*, *d*, *e*, *f*, B, be a boundary of a field, and A B the chain line, and the area of the space between them required. In measuring along A B, observe when you are directly opposite to the several bends in the boundary line, as at *g*, *h*, *i*, &c. and measure the perpendicular offsets *g b*, *h c*, *i d*, &c. with a tape; then calculate the area of each triangle, or trapezoid, into which the space is divided, separately, and their sum will be the whole area.

*Fig.* 5.



*Note.* When the boundary is *curvilinear*, its area may be found by the method of equidistant ordinates, as given in the next problem.

*Example.*—Given A *g* = 120 links, *g b* = 62, A *h* = 220, *h c* = 40, A *i* = 280, *i d* = 50, A *k* = 364, *e k* = 38, A *l* = 478, *lf* = 82, and A B = 576; what is the area of the space A *b c d e f* B A?

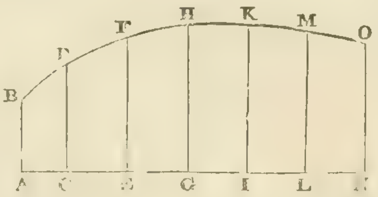
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A *g* | × *g b* | = | 120 | × | 62 | = | 7440 |
| *g h* | × (*b g* + *c h*) | = | 100 | × | 102 | = | 10200 |
| *h i* | × (*c h* + *d i*) | = | 60 | × | 90 | = | 5400 |
| *i k* | × (*d i* + *e k*) | = | 84 | × | 88 | = | 7392 |
| *k l* | × (*e k* + *fl* ) | = | 114 | × | 120 | = | 13680 |
| *l* B | × *fl* | = | 98 | × | 82 | = | 8036 |

2)52148

| | A. | R. | P. | E. |
|---|---|---|---|---|
| ·26074 = | 0 | 1 | 1 | 25. |

*Problem* 5.—*To find the area of any curvilinear field, by means of equidistant ordinates.*—Rule. If a right line A N (fig. 6,) be divided into any even number of equal parts, as A C, C E, E G, &c. and if from the points of division perpendicular ordinates, as AB, CD, E F, &c. be erected; also if A denote the sum of the first and last ordinates, B the sum of the even ordinates, *viz.* the second, fourth, sixth, &c. C, the sum of all the rest, *viz.* of the odd ordinates, wanting the first and last, and D the common distance of the ordinates; then will (A + 4 B + 2 C) × ⅓ D = the area A B O N nearly.

*Fig.* 6.



*Example.*—The lengths of five equidistant ordinates of an area are 10, 11, 14, 16, 16, and the length of the whole base 20; what is the area?

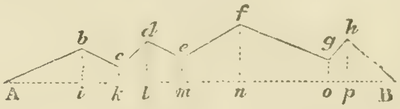
Here A = 10 + 16 = 26, B = 11 + 16 = 27, C = 14, and D = 5.

Now (A + 4 B + 2 C) × ⅓ D = (26 + 108 + 28) × $\frac{5}{3}$ = 270. Answer.

*Note.* In this example we have multiplied the sum of the ordinates by 5, and divided the product by 3, because there are in all *five* ordinates, and the formula compounds them into 3 terms A, B, C. Were there 20 ordinates there would be 12 terms, and we should then have $\frac{20}{12}$ D as our multiplier. In the question before us, 26 + 108 + 28 = 156, which multiplied by 5 = 780; and this divided by 3 is 270, the *answer* as before.

*Problem* 6.—*To reduce spaces consisting of several trapezoids, or triangles, to one triangle of the same area, by the parallel ruler.*—Rule. At A (fig. 7,) draw an indefinite line *a* A *a*; lay a parallel ruler from A to *c*, the 3d point, move the upper part of the ruler to *b*, and mark where it cuts *a* A *a*, as at 1;—from 1 lay the ruler to *d*, bring its lower edge down to *c*, and mark where it cuts *a* A *a* at 2;—from 2, lay the ruler to *e*, and move the upper edge to *d*, and mark where it cuts *a* A *a* at 3;—from 3, lay the ruler to *f*, and bring the lower edge down to *e*, and mark where it cuts *a* A *a* at 4;—from 4, lay the ruler to B, and raise the upper edge to *f*, and mark where it cuts *a* A *a* at 5. From 5 draw the line 5 B; then will the triangle A B 5 be equal in area to the sum of the two triangles and four trapezoids in the given space.

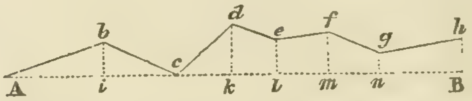
*Fig.* 7.



*Examples.*—1. Reduce the space of which fig. 7 is a sketch, to a triangle of equal area, supposing the measures to be stated in the first exercise to problem 4.

2. Reduce the space of which fig. 8 is a sketch, to a triangle of the same area, the measures being as follows: A *i* = 68, *i b* 31, A *k* 118, *k c* = 15, A *l* = 146, *l d* = 40, A *m* = 181, *m e* = 24, A *n* = 245, *n f* = 62, A *o* = 340, *o y* = 24, A *p* = 358, *p h* = 44, and A B = 418.

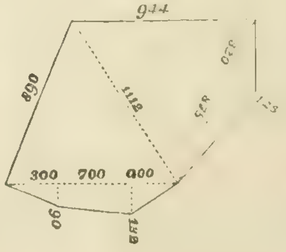
*Fig.* 8.



*Problem* 6.—*To measure any field.*—Case 1. *When the measures can be taken within the field.*—Rule. Walk over the ground, and consider how it may be best laid out into triangles, trapezoids, &c. and what lines are most suitable to the purpose of accurate measurement, and will occasion least trouble in walking forward and backward. Draw an eye-sketch of the ground in your field book, measure all the necessary lines, and note them down beside the corresponding parts in the sketch; then calculate the content of each part separately in square links, and their sum reduced to acres, &c. will be the content of the field.

Case 2. *When the ground is covered with wood, water, &c. so that the necessary internal lines cannot be taken.*—Rule. Measure a trapezium surrounding the field, so that the lines measured may make one or more right angles with each other, and measure perpendiculars from those lines to all the angular points of the field. Thus a true plan of the field may be constructed, from which the content may be found, either by deducting the areas of the small parts without the field, from the general content of the outer trapezium, or by equalizing the sides of the figure, by the parallel ruler, by problem 5.

*Fig.* 9.



*Example.*—Find the content of the field, of which fig. 9 is a sketch, from the measures marked on the sketch.

1112 } 339 = 2·5301997
900 } 551 = 2·7411516
890 } 561 = 2·7489629

2) 2902
1541 .... = 3·1616674

2) 11·1819816
389933 = 5·5909908

878 × 123 = 107994
200 × 132 = 26400
400 × 222 = 88800
300 × 90 = 27000

2) 250194
Offsets...... = 125997

1112 } 355 = 2·5502284
944 } 523 = 2·7185017
878 } 589 = 2·7701153

2) 2934
1467 .... = 3·1664301

2) 11·2052755
400532 = 5·6026377

*Area of 1st triangle* = 389933
*Area of 2d triangle* = 400532
*Area of offsets* = 125097

*Area of the field* = 9·15562

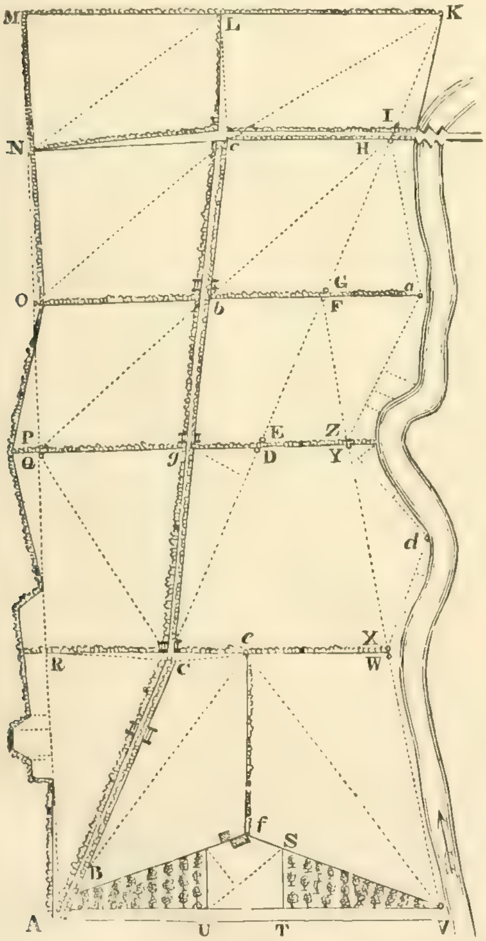
9·15562 acres = 9 acres 24 falls. *Ans.*

***Remark.*** Land measurers, for the sake of expedition, often measure in the field such lines only as will enable them to draw a geometrical plot of it; and having plotted it, they divide the plot into triangles, &c. the bases and perpendiculars of which they determine by the scale, and thence compute the content.

Problem 7.—*To measure several fields lying contiguously to one another.*—Rule. When only a few fields are to be measured, the lines may be taken in each field as directed in problem 6; but when many contiguous fields are to be measured and planned, it will be more accurate and expeditious to proceed as follows:

Select two convenient stations, as far distant from each other as may be, and from which as much as possible of the ground to be measured may be seen;—measure with great care the distance between these stations as the principal base, noting every hedge or other remarkable object as you pass it, and measuring short perpendicular lines to the bends of such hedges, &c. as are near at hand. From the ends of this base, or from any convenient points in it, measure other lines to some remarkable object situate towards the sides of the ground, noting as before every object as you pass it. These lines, when laid down by intersections, will form one or more large triangles on the ground, on the sides of which other smaller triangles and trapezoids may be formed, till you have sufficient data for plotting and ascertaining the area of the several fields of which the ground consists.

*Fig.* 10.



*Remark.* When a field book is used, it may be divided into three columns. In the middle column may be set down the angular observations, and the distances on the chain line at which any offset or remark is made, and also the whole distance from station to station; in the side columns may be entered the offsets and remarks made on the right and left hand respectively, and sketches made of boundaries, &c.; and it will be best to begin at the bottom of the page, and write upwards.

*Example.*—Let the farm, of which fig. 10 is a sketch, be planned, and the content of each field found from the measures stated in the field book in the next page.

*Problem* 8.—*To measure and plot hilly ground.*—Rule. In order to ascertain the true content of a piece of hilly ground, the whole surface must be measured, as in the case of level ground; but in plotting hilly ground, the area of the base only must be taken. The length of the base line of a hill is found thus:—As radius is to cosine of the angle of acclivity or declivity, so is the surface line ascending or descending the hill to the base or plotting line.

*Example.*—The surface line measured up a hill is 500 links, and the angle of acclivity 15° 10′; what is the base or plotting line?—Answer. Rad : Cos. 15° 10′ : : 500 : 482·58 links.

*Remark.* It is a very common practice among land measurers to give for the true content of hilly ground the area of the horizontal plane, instead of the real area of the surface. In defence of which practice it is usually alleged, that "since plants shoot up vertically, the vegetable produce of a swelling eminence can never exceed what would have grown from its levelled base." But whether this be true to the extent here asserted or not, is a point for the land valuator to determine. It belongs not to the province of the land measurer; his duty obviously is, to ascertain the true area of the surface, and to leave the consideration of the value of the ground, and of its capacity for producing, to those whom it may concern.

*Remarks on the Field Book.*—1. The farm, of which the following is a field book, was measured as follows:—The survey was begun at A, poles being placed, in a straight line, at A, B, C, D; the distances between these points were measured; then pits being dug with a spade in the places where the poles at A and B were fixed, (which should always be done at every point where a pole is placed,) these poles were removed from A and B, and placed at E and F, in a straight line with the poles at C and D, and the measurement continued to F. The poles were then removed from C and D, and placed at G and H, in a straight line with the poles at E and F, and the measurement continued to H. Then the poles at E and F were placed at I and K, and the measurement continued to K, the end of the line. Poles were then placed at L and M, and the distance K M measured. In like manner, poles being placed at M, N, O, P, &c. in a straight line, the distance M A was measured. Poles were then placed at A, T, U, V, and the line A V measured. Poles were then placed at W, X, Y, &c. and the line V F measured. In like manner were the other lines marked in the sketch measured.

2. In planning this survey, the learner should first lay down by the scale and compasses, the large triangle A K M, and then the triangle A F V, drawing the lines with a sharp-pointed black lead pencil;—he should next mark off the several distances A B, A C, A D, &c. writing the mark O where each pole was placed;—he should next measure the offsets to the angles, &c. and where the hedges were crossed;—he should then draw the fences, house, planting, &c.; and when the whole is laid down, it should be carefully inked in, and the black lead lines rubbed out with Indian rubber.

## FIELD BOOK.

| Offsets and Remarks on the Left. | Distance | Offsets and Remarks on the Right. |
|---|---|---|
| *Closes at F* | 4460 | |
| | 3450 | Z |
| *Crosses* | 3420 | *Hedge* |
| | 3400 | Y |
| *Crosses* | 2000 | *Hedge* |
| | 1900 | X |
| *Crosses* | 1850 | *Hedge* |
| | 1800 | 60 *W. river* |
| | 1700 | 10 *River* |
| *Crosses* | 15 | *Hedge* |
| | V | 15 to *River* |
| *Cor. of planting* 15 | 2620 | 15 |
| *Cor. of planting* 15 | 1535 | 15 |
| *Cor. of planting* 15 | 1000 | 15 |
| | A | *Road* |
| *Closes at* A | 6540 | *End of the line* |
| *Enters on road* | 6380 | |
| | 5525 | 0 *Touches fence* |
| | 5520 | 200 *Corner of fence* |
| | 5310 | 270 *Fence* |
| | 5100 | 270 *Fence* |
| | 5030 | 120 *Boundary fence* |
| | 4600 | 180 R *Crosses fence* |
| | 4190 | 200 *Boundary* |
| *Touches* | 4100 | 0 *Boundary* |
| | 3120 | Q |
| *Crosses hedge* | 3100 | 150 *Boundary* |
| | 3080 | P |
| *Crosses hedge* | 2430 | *Boundary* |
| *Boundary* 80 | 2070 | O |
| *Boundary* 20 | 1000 | N |
| | M | |
| | 3000 | M *End of the line* |
| | 1600 | L |
| *Turns to left* | K | |
| | 7090 | K *End of the line* |
| | 6160 | 110 I *to river* |
| *Crosses* | 6090 | *Road* |
| *Crosses* | 6050 | *Hedge* |
| | 6030 | H |
| | 4850 | G |
| *Crosses* | 4820 | *Hedge* |
| | 4800 | F |
| | 3720 | E |
| *Crosses* | 3680 | *Hedge* |
| | 3630 | D |
| *Corner of hedge* 430 | 3500 | |
| *Leaves road* | 2150 | *Crosses hedge* |
| *Breadth of* 20 | 2020 | 20 *Road* |
| B | 2000 | |
| | 130 | 20 *Corner of planting* |
| *Breadth of* 20 | A | 20 *Road* |

*Survey begins here.*

| Offsets and Remarks on the Left. | Distance. | Offsets and Remarks on the Right. |
|---|---|---|
| *House* | 200 | *Length* |
| | 30 | *Breadth* |
| *From* S | 480 | *to* U |
| *From* T | 680 | *to* S |
| 300 | 280 | |
| | T | |
| *From* V | 1510 | *to f* |
| *From* V | 1170 | *to Corner of planting* |
| *From e* | 2200 | *to* V |
| *From* B | 1200 | *to f* |
| *From* B | 1000 | *to Corner of planting* |
| *From e* | 1300 | *to f* |
| *From e* | 550 | *to* C |
| *From* B | 2150 | *to e* |
| *Closes* | 860 | *at* Y |
| | 780 | 120 *River* |
| | 300 | 100 *River* |
| *From* | d | |
| | 870 | *d* |
| | 600 | 60 *River* |
| | 340 | 50 *River* |
| *From* | X | *to d* |
| | 1170 | *a* |
| | 600 | 290 *River* |
| | 410 | 180 *River* |
| | 300 | 100 *River* |
| | 140 | 110 *River* |
| *From* | Z | *to a* |
| *From* C | 860 | *to* R |
| *From* Q | 1730 | *to* C |
| *From* P | 1030 | *to g* |
| *From b* | 1590 | *to* P |
| *From* O | 1240 | *to b* |
| *From* C | 1820 | *to* O |
| *From* N | 1410 | *to* C |
| *From* L | 1700 | *to* N |
| *From* C | 900 | *to* L |
| *From* K | 1800 | *to* C |
| *From e* | 1160 | *to b* |
| *From b* | 830 | *to* G |
| *From* H | 1170 | *to c* |
| *From* H | 1700 | *to b* |
| *Closes at* H | 1080 | 130 *River* |
| | 900 | 70 *River* |
| | 540 | 80 *River* |
| | 280 | 100 *River* |
| *From* | *a* | *to* H |
| *From* G | 670 | *to a* |

*Continued.*

OF THE DIVIDING OF LAND.—Land measurers are frequently employed to divide a piece of land among sundry tenants or proprietors, in proportion to their respective claims. In order to effect which, the content of the whole must first be accurately ascertained, and then the division may be made as directed in the following problems.

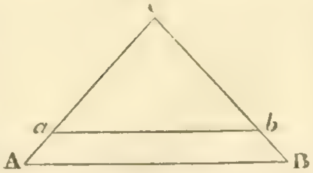
*Problem 9.—To cut off a certain portion from a parallelogram by a line parallel to one side.*—Rule. Divide the square links in the quantity required to be cut off by the links in the given side, and the quotient will shew the height on the other sides where the line of division should be drawn.

*Example.*—What length of a rectangular field, whose breadth is 750 links, will make 2 acres 3 roods 25 falls?

Here, $290625 \div 750 = 387\frac{1}{2}$ links. Answer.

*Problem 10.—To cut off a certain portion from a triangular field.*—Rule 1. When the portion is to be cut off by a line drawn from the vertex to the base:—Divide the base in the required proportion, and draw a line from the vertex to the point so found, and it will divide the field as required. For the two triangles thus formed being of the same altitude, are to one another as their bases, which are in the required proportion.—2. When the portion is to be cut off by a line parallel to one of the sides, as A B, fig. 11. From the content of the whole triangle C A B subtract the quantity to be cut off, *viz.* $a$ A B $b$, and the remainder will be the triangle C $a\,b$. Then, because the triangles C A B, C $a\,b$ are similar, and similar triangles are to one another as the squares of their like sides, as the whole content C A B is to the remainder C $a\,b$, so is the square of the side C A to the square of the side C $a$; the square root of which will be the distance from C to $a$.

*Fig.* 11.



*Example.*—The triangle A B C contains 4 acres, and the length of A C is 895 links; at what distance from C must the line of division $a\,b$ be drawn, in order to cut off $1\frac{1}{2}$ acre parallel to A B?

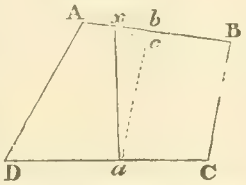
$4 : 2\frac{1}{2} :: 895^2 : 500640{\cdot}625$ and $\sqrt{500640{\cdot}625} = 707{\cdot}55$ links. Answer.

*Problem* 11.—*To cut off any quantity from a field, by a line drawn from an assigned point in the side of it.*—Rule. Set off from the given point the quantity proposed, as nearly as you can guess, and measure the ground thus set off. Then divide the difference in square links between the quantity proposed and the quantity set off, by half the length of the guess line, and the quotient will be a perpendicular, to be set off either on one side or the other of the guess line, according as the quantity set off is more or less than the quantity proposed; to which perpendicular draw a new line from the point assigned, and it will cut off the quantity required.

*Examples.*—1. From the point $a$ in the field A B C D, fig. 12, it is required to set off 1 acre 3 roods towards the side B C.

Draw $a\,b$ by guess, and measure the trapezium $a\,b$ B C; suppose you find it to be = 134,400 square links, or too little by 40600 square links, and $a\,b$ to be = 566 links. Then $40600 \div 283 = 143\frac{1}{2}$ links = $e\,x$ the perpendicular. Thus $a\,x$ is the line of division.

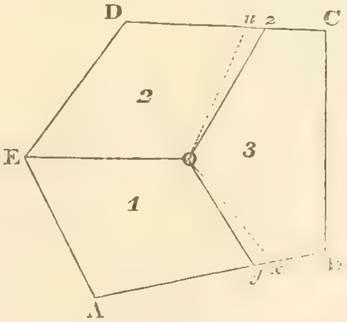
*Fig.* 12.



2. The field A B C D E, fig. 13, which contains 5 acres 3 roods 18 falls, is required to be equally divided among three claimants, so that each may enjoy the benefit of the pool of water at O?

5 a. 3 r. 18 f. = 586250 square links, and $586250 \div 3 = 195416$ square links = each share. Draw E O, and set off the guess line O $x$; measure the trapezium A E O $x$; suppose you find its area to be = 200216 square links, or too much by 4800, and the length of O $x$ to be = 500 links. Then $4800 \div 200 = 24$ links the perpendicular from O $x$ to $y$. Thus the trapezium O E A $y$ is the first share.

*Fig.* 13.



From O set off a guess line to $u$; measure the trapezium O E D $u$; suppose you find its area to be = 190916, or too little by 4500, and the length of O $u$ to be = 450 links. Then $4500 \div 225 = 20$ links, the perpendicular from $u$ to O $z$. Thus the trapezium O E D $z$ will be the second share.

The figure O $y$ B C $z$ is the third share.

*The methods of using the Plane Table and Theodolite, of Plotting, of Copying, Reducing and Enlarging Plans.*—1. Before we proceed to exemplify the method of using the plane table, it may be proper to inform the learner, that the paper should be wetted with a sponge before it is laid on the table, that it may lie the more smoothly; that at every station the table should be placed as nearly horizontal as possible, by moving the legs out or in to the height wanted, and then turned round by the socket till the north end of the needle points over the *fleur de lis* in the compass box, making the longer side of the table point N and S, and the shorter E and W; and that before an observation is made, the instrument should be made fast, by turning the screw in the socket. This being premised in order to exemplify the use of the plane table, suppose the area and plan of the field, of which fig. 76. is a sketch, were required.

Poles being placed at the angle of the field, plant the table at A, observe that it is level, and that the needle settles over the *fleur de lis*, then screw it fast; assume a convenient part of the paper to represent A, lay the thin end of the index on the point A, look through the sight, and make the pole placed at E and the hair in the sight to coincide, draw the line A E with a black lead pencil, or the point of the compasses, and lay off the measured distance A E from a scale of equal parts; then lift the index, lay its thin edge upon the point A, and take the bearing of B, draw A B, and lay off the measured distance A B, from the same scale as before. Remove the table to B, placing its centre immediately above the hole where the pole stood, slacken the screw a little, lay the thin edge of the index on B A, and take a back sight to A, hold the index fast, and move the table round, till you see the hair in the sight and the pole at A to coincide, then screw it fast, turn the index, and lay its thin edge over the point B, and when you see the hair in the sight and the point at C to coincide, draw B C, and lay off the measured distance B C as before. At every station at which a bearing is taken, before drawing the line, observe that the index has not moved from the line on which it was laid, and draw the lines as long as possible, for the index can be laid more exactly on a long line than on a short one. Remove the table to C, and having taken as before a back sight to B, lay the thin edge of the index on C, and move the index till you see the cross hair and the pole at D to coincide, then draw the line, and lay off as before the measured distance C D. Remove the table to D, and having taken as before a back sight to C, take the bearing of D E; if it answer, and the line D E to the measured distance D E, it proves that you have committed no error either in observing the angles or in measuring the distances, for if an error has been committed, the work will not meet. Errors may also be detected thus: leave a pole at any former station; apply the thin edge of the index to that pole and your present station, and look through the sight to the pole; then if no error has been commited, the needle will settle over the *fleur de lis* in the compass box; if it rest in any other direction, an error has been committed, which should be corrected before you proceed farther.

It may be observed, that the same field might also have been measured by either of the following methods.

The instrument might have been planted at any of the angles whence the other angles may be seen, as at A, and the bearings of B, C, D, and E from A observed, and also the distances A B, A C, A D, and A E, measured. Or the instrument might have been placed at any point within the field whence all the angles may be seen, as at O, and the bearings of A, B, C, D, and E from O observed, and also the distances O A, O B, O C, O D, and O E measured. By either of which methods it is plain the field may be plotted, and its area ascertained.*

2. When a survey is to made with a *theodolite*, before you begin, see that the instrument be properly adjusted, the cross hairs in the telescope exactly in the centre of the tube, and the level right. Then, having placed poles at the angles, &c. and brought the instrument to the place where you intend to begin, plant it there as firmly as you can, and also as level as possible, by moving the legs out and in, till within the limits of the level screws; then having levelled it exactly by means of the four screws between the brass plates fixed to the head of the legs, slacken a little the screw which holds the theodolite fast to the brass plates, and with both hands turn the instrument round on its axis, till the N end of the needle settles over the *fleur de lis* in the compass box, and set the index to 180° or 360° on the limb, according as it is divided into twice 180° or into 360; in the latter case the different ends of the needle will alternately agree

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* A plane table, with index and sights, ball and socket, and three-legged stand, may be purchased from any mathematical instrument-maker, for from four and a half, to five and a half guineas.

with the limb, when the observations are accurate; when the theodolite is placed so that the needle and limb may correspond, the screw that holds the instrument fast to the brass plates must be made tight; and before an observation is made, the screw which holds the telescope and quadrant fast to the limb must be so slackened, that the pinion may turn the telescope easily round with the thumb and finger, till the pole placed at the second station is seen to coincide with the cross hairs in the telescope; then the screw is tightened, the bearing of the pole at the second station marked on an eye-sketch, and the distance measured. The instrument is then to be planted at the second station, its centre being placed exactly over the hole where the pole stood. Then slacken a little the screw that holds the instrument fast to the legs, and turn the theodolite till you see through the telescope the pole left at the first station; here screw it fast again, and slacken the other screw which holds the telescope and quadrant fast, to the limb; turn the pinion round to the 3d station, and mark its bearing, and so on. The magnetic needle is used as a *test* of the accuracy of the observations; for when no error has been committed, the degrees pointed out by the needle will correspond with those on the limb.*

3. Of the principal method of *plotting*, or making a plan of an estate, the following brief directions will give the learner some idea:—Suppose the estate measured, by taking a circuit round it with the theodolite, and filling up the interior with the chain. Lay the paper on which the plan is to be drawn very smoothly on a *drawing board;* draw a pencil line from the top to the bottom, to represent the *magnetic meridian;* about the middle of that line make a point, on which lay the centre of the circular *protractor*, so that the straight edge may coincide with the meridian line; place a weight above it, to keep it steady in that position, and draw a pencil line round the edge of it. Prick off the angles at the several stations with a *plotting pin*, marking them 1, 2, 3, &c. and remove the protractor.—Consider where the beginning of the work should be placed, so that the whole may come within the compass of the paper, and there make a mark. Lay the fore edge of the parallel ruler from the central point where the protractor lay, to the mark 1 on the pencilled circle. Move the fore edge of the ruler until it touches the point fixed on for the beginning of the plot; from which draw a pencil line in the proper direction; apply a feather-edged scale to this pencil line, so that the division O may be at the beginning of it, and prick off every progressive number where any offsets have been made; then turn the scale across the line, and prick off the offsets on each side of the station line; draw the boundary lines through the offset points, and the first station will be completed. Proceed thus with each of the other stations in their order, till the work comes to a close at station first. After the principal lines are laid down, proceed to the smaller objects, till you have entered every thing that ought to appear in the plan, as houses, brooks, trees, hills, gates, roads, mills, bridges, &c. When the whole is plotted, draw a line for the *true* meridian, with a *fleur de lis* pointing north in a vacant place, lay down a *scale* of the proportion you have plotted by, *title* the map in conspicuous characters, and give it a *border*.

4. A plan may be *copied* in various ways. One method is by means of a *copying glass*, being a large square of fine glass set in a frame which can be raised up to any angle, when the lower side of it rests on a table. The paper on which the plan is to be copied, being fixed to the plan by pins at the corners, the plan is then to be laid on the glass; and by means of a strong light placed behind the frame, every line of the plan being distinctly seen through the clean paper, may be accurately traced upon it with a black lead pencil, and afterwards inked in.

Another method is as follows: Rub some sheets of *cambric* paper over with *nut-oil*, and place the oiled paper for a few days between sheets of blotting paper. When it is thoroughly dry, lay it upon the plan, with a weight above it, and with a black lead pencil go over all the lines, till you have copied the whole upon the oiled paper. Then, having rubbed one side of a sheet of thin paper uniformly over with *lead-dust*, lay the rubbed side upon the drawing paper, and the oiled plan above it, and trace the lines of the plan, pressing the tracer so as that the black lead under the lines may be transferred to the clean paper. Thus an accurate outline of the plan may be obtained, which may afterwards be inked in.

Another method is by the instrument called a *Pantograph*, by means of which a plan may be copied, reduced, or enlarged, very expeditiously, and with the greatest accuracy. This instrument is not only useful in reducing plans, but it may be employed with equal facility in copying, reducing, or enlarging *charts, maps, profiles, landscapes*, &c.

Another method is by dividing the plan into small squares, by means of equidistant parallel lines, intersecting one another, and then dividing the paper on which the plan is to be copied into the same number of squares, either less or greater than those on the plan, or equal to them, according as you wish the copy to be less, or greater than, or equal to, the original. Then observe in what squares the several parts of the plan are, and draw with a pencil similar parts in the corresponding squares of the copy; when the outline is thus obtained, it may be inked in.—*Davidson's Practical Mathematics.*

**LAND**, in the sea language, makes part of several compound terms; thus *Land-laid*, or to lay the land, is just to lose sight of it. *Land-locked*, is when land lies all round the ship, so that no point of the compass is open to the sea: *Land-mark*, any mountain, rock, &c. that serves to make the land known at sea. *Land is shut in*, signifies that another part of land hinders the sight of that the ship came from. *Land to*, or so far from shore that it can only be just discerned. *Land turn*, a wind that in almost all hot countries blows at certain times from the shore in the night. *To set the land*, that is, to see by the compass how it bears.

Land *Breeze*, a current of air, which, in many parts within the tropics, particularly in the West Indies, regularly sets from the land towards the sea during the night, and this even on opposite points of the coast.

Land *Fall*, the first land discovered after a sea voyage; hence, a good land-fall implies a discovery of the land at or near the place to which the course was directed; and a bad land fall implies the contrary.

Land *Locked*, is said of a harbour which is environed by land on all sides, so as to exclude the prospect of the sea, unless over some intervening land.—*To Make the Land*, is to discover it after having been out of sight of it for some time.

Land *Mark*, any mountain, rock, steeple, or the like, near the sea-side, which serves to direct ships passing by, how to steer, so as to avoid certain dangers, rocks, shoals, whirlpools, &c.

Land *Waiter*, an officer of the custom-house, whose duty is, upon landing any merchandise, to examine, taste, weigh, measure them, &c. and to take an account thereof. In some ports they also execute the office of a coast-waiter. They are likewise occasionally styled searchers, and are to attend and join with the patent searcher in the execution of all cockets for the shipping of goods to be exported to foreign parts; and in cases where drawbacks on bounties are to be paid to the merchant on the exportation of any goods, they, as well as the patent searchers, are to certify the shipping thereof on the debentures.

Land *Tax*, one of the annual taxes raised upon the subject. *See* Tax. The land tax, in its modern shape, has superseded all the former methods of rating either property, or persons in respect of their property, whether by tenths or fifteenths, subsidies on land, hydages, scutages, or talliages; a short explication of which will, however, greatly assist us in understanding our ancient laws and history. An act passes annually for the raising in general, £2,037,627. 9*s.* 10½*d.* by the abovesaid tax, at 4*s.* in the pound; whereof there shall be raised in the several counties in England, according to the proportions expressed in the act, £1,989,673. 7*s.* 10½*d.*; and in Scotland, £47,954. 1*s.* 2*d.* by an eight months' cess of £5994. 5*s.* 1¾*d.* per measure, to be raised out of the land rent, and to be paid at four terms, as specified in the act, by two months' amount each time.

**LANDEN**, John, an eminent English mathematician, was born at Peakirk, near Peterborough, in January, 1719. He became an early proficient in the mathematical sciences, and was a contributor to the Ladies' Diary in 1744, and continued his labours in that useful little performance nearly till his death, in January, 1790.

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* Theodolites sell from five guineas to thirty pounds, and upwards, according to their construction.

**LANDSCAPE.** *See* PAINTING.

**LANDSMEN**, the distinctive appellation of those on board a ship who have never before been at sea.

**LANGREL**, or LANGRAGE, a particular kind of shot, formed of bolts, nails, and other pieces of iron tied together, and forming a sort of cylinder, which corresponds with the bore of the cannon from which it is discharged, in order to wound or carry away the masts, or tear the sails and rigging of the adversary. It is seldom used but by privateers or merchantmen.

**LANGUAGE.** Man, of all animals, only is possessed of speech. Mere sound is, indeed, the sign of what is pleasurable or painful, and it is, for that reason, common to most other animals; for in this manner do they signify their feelings to each other. But speech indicates what is expedient or hurtful, and, a natural consequence, of what is just or unjust, it is therefore given to man, by that great Being who endowed him with consciousness; for a sense of good and evil is peculiar to man alone.

1. The most intelligent of the brute creation frequently astonish us by actions, which can proceed only from powers of intellect similar to our own; the capacity of speech, then, is the criterion of distinction between man and the brute creation. Reason, the capital faculty and characteristic of man, would, without this extensive power of communication, have remained in inactivity, its energies unexcited, and its faculties torpid.

When the influence of language upon intellect is fully and maturely considered, it will be found that the most brilliant discoveries in philosophy and science are derived from this source. If those, whose genius has dazzled the world with its splendour, had been deprived of the observations and the researches of others, they would not have risen above the level of the least cultivated, and most uninformed. Take from man the use of speech, and of visible signs, his intellectual faculties would indeed be circumscribed within very narrow limits.

2. The *human voice* is air sent out from the lungs, and so agitated and modified in its passage through the wind-pipe and larynx, as to be distinctly audible. The windpipe is that tube which, on touching the forepart of our throat externally, we feel hard and uneven; it conveys air into the lungs for the purpose of respiration and speech. It consists of cartilages, circular before, that they may resist external injury; but flattish on the opposite side, that they may not hurt the æsophagus, or gullet, which lies close behind, and is the tube which conveys food into the stomach. These cartilages are separated by fleshy membranes; by means of which the windpipe may be shortened or lengthened, and when necessary, incurvated without inconvenience. The upper part of windpipe is called the larynx; it consists of four or five cartilages, that may be expanded or brought together by the agency of the muscles, which operate all at the same time.

3. In the middle of the larynx there is a small aperture called the glottis, through which the breath and voice are conveyed, but which when we swallow, is covered by a lid, called the epiglottis; for if any part of our food get into the windpipe by this passage, it occasions coughing, till it is thrown out again. The best authors have determined, that the human voice is produced by two semicircular membranes in the middle of the larynx, which form by their separation the aperture termed the glottis. The space between them is not more than the tenth part of an inch in width, through which the breath transmitted from the lungs passes with considerable velocity. It gives, in its passage, a brisk vibratory motion to the membranous lips of the glottis, and thus forms the sound called *voice;* this is strengthened and mellowed by reverberation from the palate and other cavities in the mouth and nostrils; and as these are better or worse adapted for reverberation, the voice is more or less harmonious.

4. The origin of language is involved in much obscurity. We are informed by the sacred historian, that the rudiments of language were given to man by his Maker; for *Adam named all creatures:* we must not, however, imagine that this was a perfect system,—it was but the first step. It is natural to suppose, that God taught our first parents only such language as suited their present occasions, leaving them to enlarge and improve it as their necessities required. Supposing a period to exist, when words were uninvented or unknown, men would have had no other method of communicating their feelings to others than by the cries of passion, accompanied by such gestures, as were expressive of emotion. These are the only signs which nature teaches, and they are intelligible to all. Were two men, ignorant of each other's language, to meet together, each would endeavour to express himself by gesticulation, by signs, or by short and sudden exclamations; which would be uttered in a strong and passionate manner. These, grammarians have denominated *interjections*, and they were undoubtedly the first elements of speech.

5. When more enlarged communication became requisite, and names began to be applied to objects, the nature of the object was assimilated as much as possible to the sound of the name. To describe any thing harsh or boisterous, a harsh or boisterous sound was employed; names were never given in a manner purely arbitrary. In the *Hebrew*, the names of animals given by Adam, bear a striking analogy to the individuals they represent. In the infancy of language, nothing was more natural than to imitate, by the sound of voice, the noise produced by external objects: a number of words may be discovered, constructed upon this principle. When one sort of wind is said to *whistle*, and another to *roar;* when a serpent is said to *hiss;* a fly to *buzz*, and falling timber to *crash;* a stream to *flow*, and hail to *rattle;* the resemblance of the word to the thing signified, is plainly discernible. The native of Taheite, (usually but improperly written Otaheite,) gives to the gun the appellation of *tick-tick-boo*, evidently imitating the cocking and report of a firelock. The *cuckow* also derives its name from its note. These, and a host of instances in other languages, prove that words were, originally, imitative. As the multitude of terms, however, increased, and the vast field of learning was filled up, words, by a thousand fanciful and irregular methods of derivation and composition, deviated widely from the primitive character of their roots, and lost all resemblance to the objects which they were intended to represent. Words may be considered as symbols, not as imitations; as arbitrary or instituted, not natural, signs of ideas.

6. In the early ages of the world, there is every reason to suppose that the difference of the language in Europe, Asia, and Africa, was no more than a difference of dialects; and that the people of Greece, of Phenicia, and of Egypt, mutually understood each other. The *oriental* origin of the Latin and Greek is now generally acknowledged; and to these, the Teutonic dialects have an affinity; the Arabic, the Chaldee, the Syriac, and the Ethiopic, still bear the most striking resemblance to the *Hebrew;* in the Welsh, are many words analogous to it: the Celtic, also, has derived much from this and other eastern languages. The Hebrew, then, if we judge from these remarkable facts,—from the mode of its derivation, from its radicals, or from the simplicity of its structure,—must undoubtedly be considered as the primitve or parent language.

7. An eminent linguist of the present day, thinks it very likely that the original language was composed of monosyllables, that each had a distinct ideal meaning, and only one meaning; as different acceptations of the word would undoubtedly arise, either from compounding terms, or when there were but few words in the language, using them by a different mode of pronunciation, to express a variety of things. Where this simple, monosyllabic language prevailed, (and it must have prevailed in the first ages of the world,) men would necessarily have *simple ideas*, and a corresponding *simplicity of manners.* The Chinese language is exactly such as this; and the Hebrew, if stripped of its vowel points; and its prefixes, suffixes, and postfixes, separated from their combinations, so that they might stand by themselves, would nearly answer to this character, even in its present state. The same author, speaking of the confusion of tongues, thinks, that God caused the workmen employed in building the Tower of Babel, to articulate the same word differently,—to affix different ideas to the same term,—and perhaps, by transposing syllables, and interchanging letters, to form new terms and compounds, so that the mind of the speaker was apprehended by the hearer in a contrary sense to what was intended.

**LANGUOR**, among Physicians, signifies great weakness and loss of strength, attended with a dejection of mind; so that the patients can scarce walk or even stand upright, but are apt to faint away.

**LANIARD**, or **Lanniers**, a short piece of rope or line, fastened to several machines in a ship, and serving to secure them in a particular place, or to manage them more conveniently; such are the laniards of the gun ports, the laniards of the buoy, the laniard of the cat-hook, &c. The principal laniards used in a ship are those employed to extend the shrouds and stays of the mast by their communication with the dead-eyes and hearts, so as to form a sort of mechanical power resembling that of a tackle. The following is the manner in which those laniards are fixed in the dead-eyes; one end of the laniard is thrust through one of the holes in the upper dead-eye, and then knotted to prevent it from drawing out; the other end is then passed through one of the holes in the lower dead-eye, whence returning upward, it is inserted through the second hole in the upper dead-eye, and next through the second in the lower dead-eye, and finally through the third holes in both dead-eyes. The end of the laniard being then directed upwards from the lowest dead-eye, is stretched as stiff as possible by the application of tackles, and that the several parts of it may slide with more facility through the holes in the dead-eyes, it is well smeared with hog's lard or tallow, so that the strain is immediately communicated to all the turns at once.

**LANISTER**, in Antiquity, is sometimes used to signify an executioner, but more frequently for a master gladiator, who taught the use of arms, and had always people under him ready to exhibit shows of that kind. For this purpose, they either purchased gladiators, or educated children in that art, that had been exposed.

**LANIUS**, the *Shrike*, in Natural History, a genus of birds of the order picæ. There are fifty-six species. The great shrike is about the length of ten inches, and found in France in great numbers, but rare in England. It subsists on insects and small birds, seizing the last by the throat and strangling them, and then fixing them on a thorn, from which it tears them piecemeal and devours them. To decoy them within its reach, it imitates the song of many birds, which approach, delighted by the sounds, and unsuspicious of the danger. It is a favourite bird with husbandmen, as it is considered by them a mortal enemy to rats, mice, and other species of vermin. It, however, prefers mountainous and secluded situations to the neighbourhood of mankind.

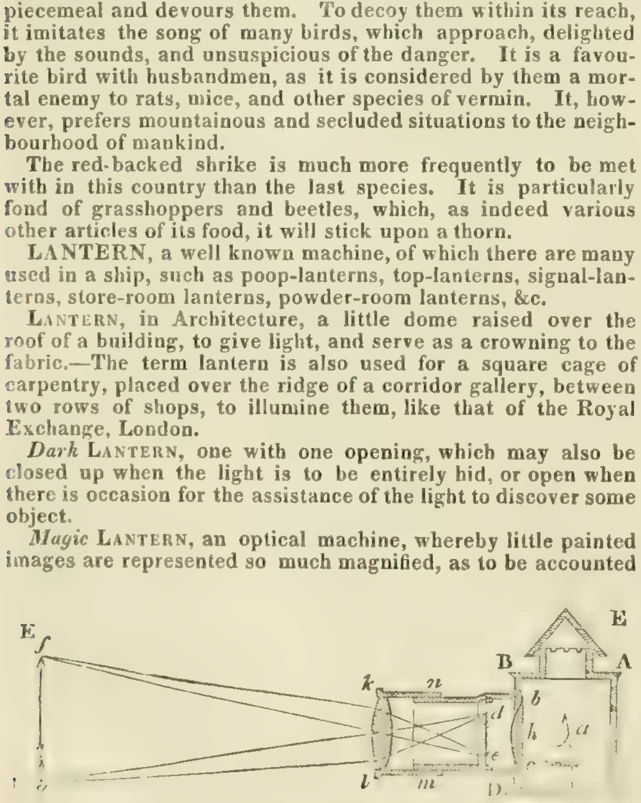
The red-backed shrike is much more frequently to be met with in this country than the last species. It is particularly fond of grasshoppers and beetles, which, as indeed various other articles of its food, it will stick upon a thorn.

**LANTERN**, a well known machine, of which there are many used in a ship, such as poop-lanterns, top-lanterns, signal-lanterns, store-room lanterns, powder-room lanterns, &c.

**Lantern**, in Architecture, a little dome raised over the roof of a building, to give light, and serve as a crowning to the fabric.—The term lantern is also used for a square cage of carpentry, placed over the ridge of a corridor gallery, between two rows of shops, to illumine them, like that of the Royal Exchange, London.

*Dark* **Lantern**, one with one opening, which may also be closed up when the light is to be entirely hid, or open when there is occasion for the assistance of the light to discover some object.

*Magic* **Lantern**, an optical machine, whereby little painted images are represented so much magnified, as to be accounted the effect of magic by the ignorant. The contrivance is briefly this: A B C D is intended to represent a tin lantern, from whose side there proceeds a square tube *b n k l m c*, consisting of two parts; the outermost of which, *n k l m*, slides over the other, so as that the whole tube may be lengthened or shortened by that means. In the end of the arm *n k l m*, is fixed a convex glass, *k l*; about *d e* there is a contrivance for admitting and placing an object, *d e*, painted in dilute and transparent colours, on a plane thin glass; which object is there to be placed inverted. This is usually some ludicrous or frightful representation, the more to divert the spectators.



**LAPIDARY**. The cutting and polishing of gems is the work of the lapidary, and is in general thus performed: The form most proper to be given to any particular gem being determined on, it is cemented to the end of a stick, and the different facets are formed by a mill contrived for the purpose. This mill is a plate of copper, or an alloy of lead and tin, to which an horizontal motion is given by very simple machinery, and the surface of which is charged either with diamond powder and oil, or with fine emery and water. A thick peg of wood, called a gauge, pierced with small holes in all directions, is set upright on the lapidary's bench, close to the mill, and the process of forming the facets thus takes place. The stone is placed on the surface of the mill, the opposite end of the stick to which it is cemented being inserted in one of the holes of the gauge. In this position it is kept steady by the workman with the right hand, whilst with the other he puts the mill in motion. The skill of the lapidary depends on regulating the velocity of the mill, and pressing with more or less force on the stick, with an almost imperceptible tendency to one or other direction in different stages of the work, examining each facet at very short intervals, in order to give as great precision as possible to its size and form. This part of the business being completed, the cutting mill is taken out, and replaced by one of brass, on which the polishing is performed by means of fine emery, tripoli, and rotton-stone, exactly in the same manner as is practised in the first stage of the process for setting the facets.

**LAPIDESCENT**, any thing which has the faculty of petrifying, or turning bodies to a stony nature. The older naturalists speak of lapidescent juices.

**LAPIS**, in general, is used to denote a stone of any kind.

**LAPLYSIA**, or **Sea-Hare**, a genus of marine animals belonging to the class of vermes.

**LAPSANA**, *Nipplewort*, a genus of plants belonging to the syngenesia class, and in the natural method ranking under the 49th order, compositæ.

**LAPSE**, in Ecclesiastical Law, a slip or omission of a patron to present a clerk to a benefice within six months of its being void; in which case, the benefice is said to be in lapse, or lapsed, and the right of presentation devolves to the ordinary.

**LAPSED Legacy**, is where the legatee dies before the testator, or where a legacy is given upon a future contingency, and the legatee dies before the contingency happens.

**LAP-sided**, the state of a ship which is built in such a manner as to have one side heavier than the other, and by consequence to retain a constant heel or inclination towards the heaviest side; unless when she is brought upright by placing a greater quantity of the cargo or ballast on the other side.

**LAQUEARIUS**, a kind of master wrestler, or champion, among the ancients, who in one hand held a laqueus, *i. e.* a sort of snare, wherewith to embarrass and entangle his antagonist, and in the other a poniard to stab him.

**LAQUERING**, the laying on metals coloured or transparent varnishes, to produce the appearance of a different colour in the metal, or to preserve it from rust. Thus, laquered brass appears gilt; and tin is made yellow. Seed-lac is the chief composition for laquers, but turpentine makes a cheaper laquer.

*To imitate Gilding on Brass*, take one ounce of turmeric, add a drachm of saffron, and another of arnotto, and add to these a pint of spirits of wine. Place the bottle in a moderate heat, shake it frequently for several days, and in the end you will procure a fine yellow. Add now three ounces of seed-lac, and when this is dissolved, strain off the mixture: or you may mix one ounce of turmeric root ground, half a drachm of dragon's blood, and a pint of spirits of wine. Saffron is sometimes used to form the body of colour in this laquer, instead of the turmeric; it makes a warmer but more expensive yellow, and as turmeric has the advantage in forming a much stronger tinge in spirits of wine, it receives the preference. Aloes and gamboge are also sometimes used in laquers for brass: aloes are not necessary where turmeric or saffron is used; and the gamboge, though a strong juice in water, affords but a weak tinge in spirits of wine.

*A Laquer for Tin, to imitate a Yellow Metal.* Take one ounce of turmeric root, of dragon's blood two drachms, and one pint of spirits of wine; add a sufficient quantity of seed-lac.

*A Laquer for Locks, &c.* Seed-lac varnish alone, or with a little dragon's blood; or a compound varnish of equal parts of seed-lac and resin, with or without the dragon's blood.

*A Gold-coloured Laquer for Gilding Leather.* The *gilt leather* used for skreens, room-borders, &c. is leather covered with *silver* leaf, and laquered with the following composition: Take four pounds and a half of fine white resin, of common resin the same quantity, of gum-sandarach two pounds and a half, and of aloes two pounds; bruise those which are in great pieces, mix them together, put them into an earthen pot over a good charcoal fire, or any fire without flame. Melt all the ingredients, stirring them well with a spatula, that they may be thoroughly mixed, and prevented also from sticking to the bottom of the pot. When they are perfectly melted and mixed, add gradually to them seven parts of linseed oil, and stir the whole with the spatula. Make the liquid boil, stirring it all the time, to prevent the sediment from sticking to the bottom of the vessel. When the varnish is boiled seven or eight hours, add gradually half an ounce of litharge, or half an ounce of red-lead, and when they are dissolved, pass the varnish through a linen cloth, or flannel bag. The way of knowing when the varnish is sufficiently boiled, is by taking a little on some instrument, and if it draws out and is ropy, and sticks to the fingers, drying on them, it is prepared.

**LAQUEUS**, in Surgery, a kind of ligature, so contrived, that, when stretched by any weight, or the like, it draws up close. Its use is to extend broken or disjointed bones, to keep them in their places while they are set, and to bind the parts close together.

**LARBOARD**, a name given by seamen to the left side of a ship when the spectator's face is turned in the direction of the head.

LARBOARD-*Tack*, is when a ship is close hauled, with the wind blowing on her larboard side.

LARBOARD-*Watch*, a division of a ship's company on duty while the other is relieved from it. *See* the article WATCH.

**LARBOWLINES**, a cant term used by the boatswain's mates, implying the larboard watch.

**LARCENY**, or THEFT, by contraction for *latrociny*, *latrocinium*, is distinguished by the law into two sorts: the one called *simple larceny*, or *plain theft*, unaccompanied with any other atrocious circumstance; and *mixed* or *compound larceny*, which also includes in it the aggravation of a taking from one's house or person. 1. Simple larceny, when it is the stealing of goods above the value of twelvepence, is called grand larceny; when of goods to that value, or under, is petty larceny: offences, which are considerably distinguished in their punishment, but not otherwise. *See* THEFT. 2. Mixed or compound larceny, is such as has all the properties of the former, but is accompanied with either one or both of the aggravations, of a taking from one's house or person.

**LARD**, the fat of swine, which differs in its situation from that of almost every other quadruped, as it covers the animal all over, and forms a thick, distinct, and continued layer betwixt the flesh and the skin, somewhat like the blubber in whales, applicable to various purposes both culinary and medicinal; and particularly to the composition of ointments. The usual mode of preparation is to melt it in a jar placed in a kettle of water, and in this state to boil it, and run it into bladders that have been cleaned with great care. The smaller the bladders are, the better the lard will keep. The fat which adheres to the parts connected with the intestines differs from common lard, and is preferably employed for the greasing of carriage wheels.

**LARES**, among the ancients, derived by Apulius De Deo Socratis, from *lar familiaris*, a kind of domestic genii, or divinities, worshipped in houses, and esteemed the guardians and protectors of families, supposed to reside more immediately in the chimney corner. The *lares* were distinguished from the *penates*, as the former were supposed to preside over housekeeping, the servants in families, and domestic affairs; and the latter were the protectors of the masters of families, their wives, and children. Accordingly, the lares were dressed in short succinct habits, to shew their readiness to serve; and they held a sort of cornucopia in their hands, as a signal of hospitality and good housekeeping. According to Ovid, there were generally two of them, who were sometimes represented with a dog at their feet. The lares are also called penates, and were worshipped under the figures of little marmousets, or images of wax, silver, or earthenware.

**LARGE**, a phrase applied to the wind when it crosses the line of a ship's course in a favourable direction, particularly on the beam or quarter; for instance, if a ship is steering west, the wind in any point of the compass to the eastward of the south or north, may be called large, unless it is directly east, and then it is said to be right aft.

SAILING *Large*, is therefore the act of advancing with a large wind, so as that the sheets are slackened and flowing, and the bowlines entirely disused. This phrase is generally opposed to sailing close-hauled, or with a scant wind, in which situation the sheets and bowlines are extended as much as possible.

**LARMIER**, in Architecture, a flat square member of the cornice below the cinasium, and jets out farthest; being so called from its use, which is to disperse the water, and cause it to fall at a distance from the wall, drop by drop, or as if by tears, the French word *larm* signifying a tear.

**LARUS**, the *Gull*, in Natural History, a genus of birds of the order anseres. They inhabit principally the northern climates, subsisting on carrion, and on fishes. Gmelin reckons fifteen species, and Latham nineteen.—L. marinus, is twenty-nine inches in length, and of the weight of five pounds. It is found in various parts of England, and on most of the northern coasts of Europe. It breeds in the most elevated cliffs, laying its eggs on heaps of dung deposited by various birds. It feeds principally on fishes, but sometimes attacks birds. The herring-gull, somewhat less than the former, frequents the same situations, and subsists, like that, chiefly upon fish. In the herring season it is seen watching the nets of the fishermen, and is daring enough frequently to seize its prey from the boats and nets.—The common gull, sixteen inches long, and about a pound in weight, breeds on the rocks and cliffs on the British coasts; and on the banks of the Thames, near its union with the sea, may be seen in immense numbers, picking up the worms and small fishes deposited by the tide. It will also follow the course of the plough over the fields, to pick up the insects and worms which are thrown up by it.—The black-cap, or pewit gull, breeds in the fens of Lincolnshire and Cambridgeshire, and, after the season of breeding is over, returns to the coasts. The old birds of this species are both rank and tough, but the young are eaten by many persons, and were formerly much admired for the table, taken so young as to be unable to fly.—The brown gull weighs about three pounds. It is more frequent in the cold than in the warmer latitudes, and is perhaps the most daring and fierce of all the species. In the Faro islands, lambs are stated to be often torn to pieces by it, and carried to its nest. On the island of Foula, however, it is said to be highly valued on account of its enmity to the eagle, which it attacks, and follows with the most animated hostility. Its feathers are thought by many to equal those of the goose.—The tarrock breeds in Scotland, and is found so far north as Spitzbergen. It is an attendant on the progress of whales and other large fishes, which drive the smaller inhabitants of the ocean into creeks and shallows, where the tarrocks suddenly dart on them, ensuring always an easy and full repast. The tarrock and its eggs are food for the Greenlanders, and of their skins are made caps and garments.

**LARVA**, in Natural History. The larva state of insects, in general, denotes caterpillars of all kinds. The caterpillar state is that through which every butterfly must pass before it arrives at its perfection and beauty.

**LASHERS**, are properly those ropes only which bind fast the tackles and the breeches of the ordnance, when they are haled or made fast within board.

**LASHING**, which denotes a piece of rope used to fasten or secure any moveable body in a ship, or about her masts, sails, and rigging, is chiefly used for binding up to the ship's side muskets, butts of water or beer, or pieces of timber to make spare top-masts.

**LASKETS**, small lines like hoops, sewed to the bonnets and drabblers of a ship, to lash or lace the bonnets to the courns, or the drabblers to the bonnets.

**LASKING**, is much the same with going larger or veering; that is, going with a quarterly wind. *See* the article Veer.

**LASSITUDE**, or Weariness, in Medicine, a morbid sensation, that comes on spontaneously, without any previous motion, exercise, or labour. This is a frequent symptom in acute distempers: it arises either from an increase of bulk, a diminution of proper evacuation, or too great a consumption of the fluids necessary to maintain the spring of the solids, or from a vitiated secretion of that juice.

**LASTAGE**, signifies the ballast or lading of a ship.

**LATEEN Sail**, a triangular sail, frequently used by xebecs, polacres, fettees, and other vessels navigated in the Mediterranean sea.

**L'ATELIER de l'Imprimeur**, *the Printing Press*, is due to the innovating spirit of Monsieur Bode, who composed this asterism out of some distinct but unformed stars situated in the Milky Way, and Eastward of Canis Major's head: *Boundaries and Contents*: north, by Monoceros, east, by Canis Major; south, by Argo Navis; and west by Monoceros, Argo Navis, and Pyxis Nautica.

**LATERAL Equation**, is a term used by some old authors for what is now more commonly called a Simple *Equation*.

**LATH**, in Building, a long, thin, and narrow slip of wood, nailed to the rafters of a roof or ceiling, in order to sustain the covering.

**Lath-Bricks**, a particular sort of bricks, made in some parts of England, of twenty-two inches in length and six in breadth, which are used in the place of laths or spars, supported by pillars in casts, for the drying of malt. This is an excellent contrivance; for besides that they are not liable to fire, as the wooden laths are, they retain the heat vastly better; so that being once heated, a very small quantity of fire will keep them so.

**LATHE**, a very useful engine for the turning of wood, ivory, metals, and other materials. The invention of the lathe is very ancient. Diodorus Siculus says, the first who used it was a grandson of Dædalus, named Talus. Pliny ascribes it to Theodore of Samos, and mentions one Thericles, who rendered himself very famous by his dexterity in managing the lathe. With this instrument the ancients turned all kinds of vases, many whereof they enriched with figures and ornaments in basso relievo. The lathe is composed of two wooden cheeks or sides, parallel to the horizon, having a groove or opening between; perpendicular to these are two other pieces called puppets, made to slide between the cheeks, and to be fixed down to any point at pleasure. These have two points, between which the piece to be turned is sustained; the piece is turned round, backwards and forwards, by means of a string put round it, and fastened close to the end of a pliable pole, and underneath to a treadle or board moved with the foot. There is also a rest which bears up the tool, and keeps it steady. As it is the use and application of this instrument that makes the greatest part of the art of turning, we shall notice it hereafter under that word; at present we shall give a particular description of *Maudsley's Lathe*, as well as the manner of applying its various parts to one another.

*Maudsley's* **Lathe**, is shewn at large in the plate. A is the great wheel, with four grooves on the rim. This wheel is worked by a crank B and trundle C, in the common way, by a catgut string, which in going round the wheel passes also round a smaller wheel D, called the *mandrel*. This mandrel has on its circumference four grooves, of different diameters, for giving it different velocities, corresponding with the four grooves on the great wheel A. To make the same band suit, when applied to all the different grooves on the mandrel D, the great wheel A can be raised or lowered by means of the screw *a*, and another at the end of the axle; and the connecting rod *e* can be lengthened or shortened by screwing the hooks at each end of it, further out of it, or more into it.

The end M of the mandrel D is pointed, and works in a hole in the end of a screw, passing through the standard E, fig. 1; the other end of the bearing F, fig. 2, is conical, and works in a conical socket in the standard F, 1; hence, by tightening up the screw in E, the conical end F may at any time be made to fit its socket: the puppet G has a cylindric hole through its top, to receive the polished pointed rod *d*, which is moved by the screw *e*, and fixed by the screw *f*; the whole puppet is fixed on the triangular prismatic bar H, by a clamp, fig. 8, the ends of which, *a b*, pass through holes, *b*, in the bottom of the puppet under the bar, and the hole is fixed by the screw *c* pressing against it: by this means, the puppet can be taken off the bar without first taking off the standard 1, as in the common lathes, and the triangular bar is found to be preferable to the double rectanglar one in common use.

The rest J, in three pieces, is a similar contrivance; see figs. 3, 4, and 5.

Fig. 4, is a piece, the opening *a*, *b*, *c*, in which is laid upon the bar H, fig. 1; the four legs *d d d d* of fig. 5, are then put up under the bar (into the recesses in fig. 4, which are made to receive them) so that the notches in *d d d d* may be level with the top of fig. 4, the two beads *e f* in fig. 3, are then slid into the notches in the top of *d d d d* fig. 4, to keep the whole together; the groove *i* receives a corresponding piece on *ef*, fig. 3, to keep it steady, the whole of fig. 3 has a metallic cover, to keep the chips out of the grooves.

It is plain, that by tightening the screw *h* in the bottom of fig. 4, the whole will be fixed and prevented from sliding along the bar H, and fig. 3, from sliding in a direction perpendicular to the bar; the piece *l*, fig. 3, on which the tool is laid, can be raised or lowered at pleasure, and fixed by the screw *m*.

On the end *n* of the spindle P, figs. 1 and 2, is screwed occasionally an *universal chuck* for holding any kind of work which is to be turned (see fig. 6.). A is the female screw to receive the screw *n*, fig. 1; near the bottom of the screw A is another screw B B, which is prevented from moving endways by a collar in the middle of it fixed to the screw A: one end of the screw B B is cut *right-handed*, and the other *left-handed*; so that by turning the screw one way, the two nuts E F will recede from each other, or by turning it the contrary way, they will advance towards each other; the two nuts E F pass through an opening in C, and project beyond the same, carrying jaws like those of a vice, by which the subject to be turned is held.

For turning faces of wheels, hollow work, &c. where great accuracy is wanted, *Maudsley* has contrived an ingenious apparatus which he calls a slide-tool, represented by fig. 7, where E E E is the opening to receive the bar H, fig. 1, and is fixed by the clamp, fig. 8, as before described; the tool for cutting, &c. is fixed in the two holders *b b* by their screws; these holders are fastened to a sliding-plate *a*, which can be moved backwards and forwards by the screw *c*, causing the tool to advance or recede; fig. 9, represents the under side (turned upward) of the part A A, in which the screw *c* is seen fixed at each end, and the nut *d*, which is attached to the under side of the plate *a*, working upon it. When it is necessary, as in the turning of the inside of cones, &c. that the tool should not be parallel to the spindle P, the screw *e* and another similar one behind must be loosened, the tool set at the proper angle, and then be screwed tight again.

To make the piece A A move truly when it is turned round, there is a hole *f*, fig. 9, to receive a knob *g*, fig. 14, upon the plate B, which acts as a centre, and keeps it in its place; there are three holes on each side in the plate B, fig. 12, to put the screw *e* in at different times, thus giving the tool a greater range than the circular openings S S will admit. The part E E E E, represented separately and inverted in fig. 10, is of cast iron, and has a screw *h* working in it similar to fig. 9; the nut of this screw is attached to the bottom of the slide H, fig. 11, at *t*, which slides in the groove *i*, figs. 7 and 10; at one end of it is a box containing a screw *m*, hereafter described, and at the other is a frame of brass K K. Near the same end of the slide is a pin L, projecting above the plate, which is put

Fig 1.

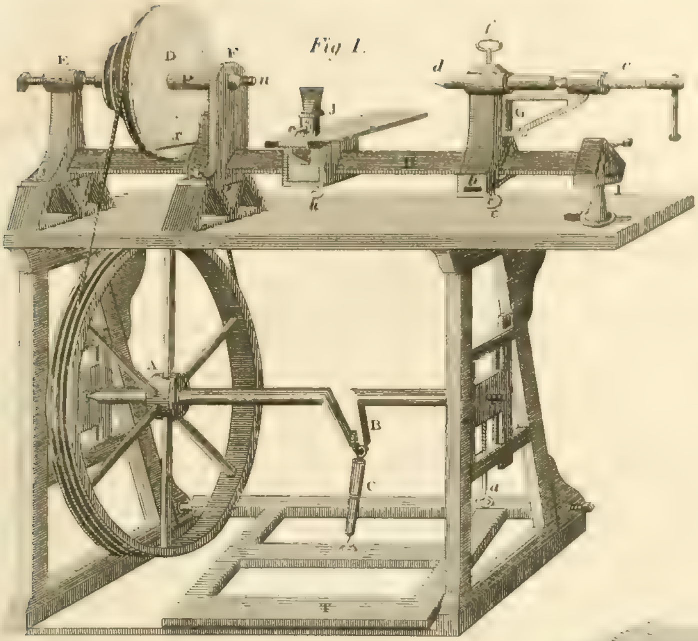


Fig 2

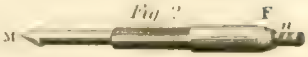


Fig 3

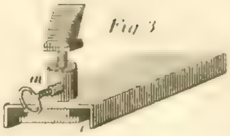


Fig 4

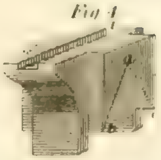


Fig 5

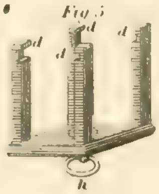


Fig 6

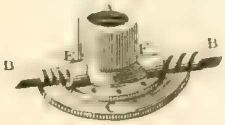


Fig 7

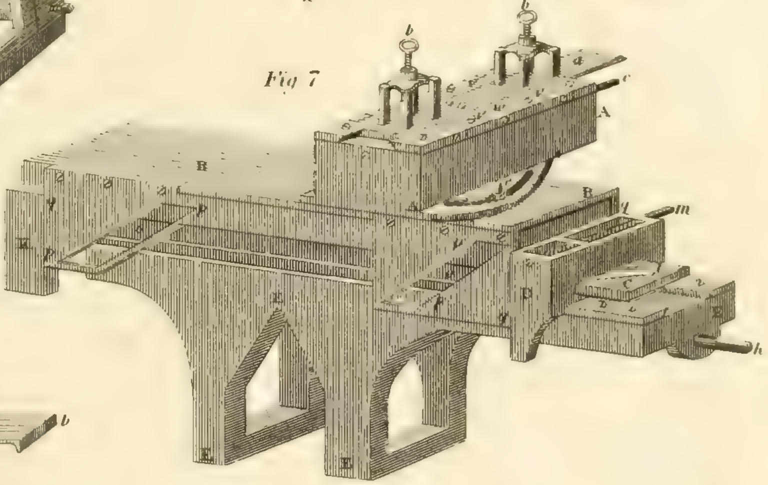


Fig. 9

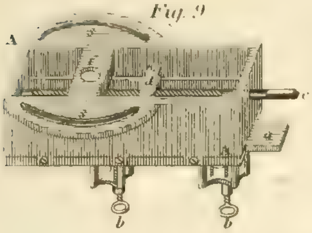


Fig 8

Fig. 10

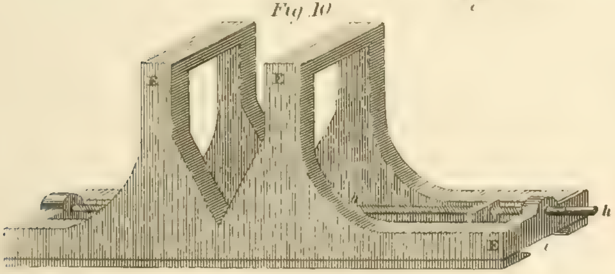


Fig. 11

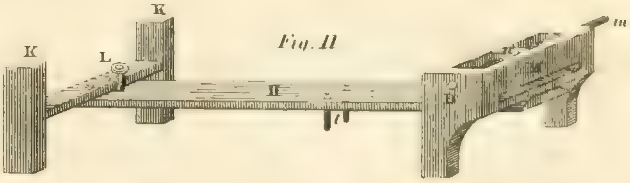


Fig 12

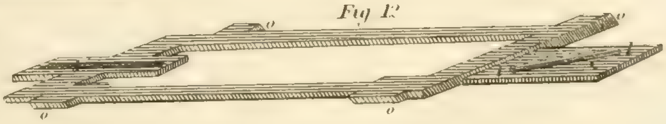


Fig. 13.

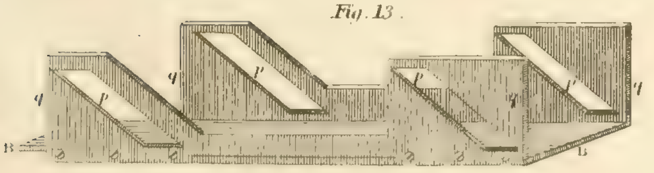
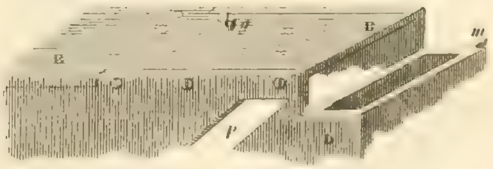


Fig. 14.



through an opening, J, in fig. 12, to steady it; while the other end C of fig. 12, is put through an opening M in the box D, fig. 11. In the part C is an oblique slit *l l* to receive a stub which projects from the bottom of the nut *n*, worked by the screw *m*, fig. 11; by this arrangement it is obvious that if the screw *m* is worked, the stub of the nut *n*, acting against the slide of the slit *l l* as an inclined plane, will move it backwards or forwards through the opening M; a metal cover *r*, fig. 14, is occasionally put over the opening for the nut *n* and screw *m*, to prevent the chips from falling in.

Near the four corners of the frame, fig. 12, are four small projections *o o o o*, with inclined sides, that fit into the four openings *p p p p* of figs. 13, and 7, these openings are cut out in two brass plates, screwed on at right angles to the plates B B, figs. 7, and 13; the ends *q q q q* of these plates slide between the edges of the frame K K and the box D, so as to prevent any other motion than a vertical one.

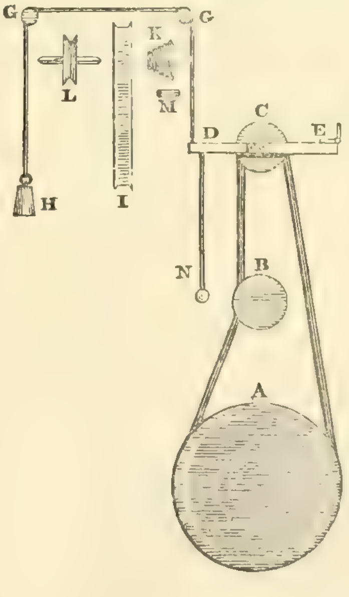
When this *slide-tool* is used, the puppet G is to be removed or pushed back further from F, and the tool is put upon the bar H, fig. 1, and fixed in the place of the rest J, by the clamp fig. 8; the distance from the centre *n* is adjusted by the screw *h*, which moves the slide, fig. 11. in the grooves *i*, figs. 7, and 10, with the whole apparatus upon it; by the screw *m*, figs. 7, and 11, as before described, the slide, fig. 12, may be moved in a direction perpendicular to the bar H, fig. 1; and its projections *o o* acting against the slits *p p*, figs. 7, and 13, as inclined planes, will raise or lower the plate B as is required.

The tool, which has been before fixed in the holders *b b*, can be set at the proper angle, by loosening the screw *e*, as previously described: and lastly, the tool with the holders and slider *a* can be advanced or withdrawn by working the screw *e*. The nuts of the screws *c*, and *h*, fig. 7, are not screwed fast to the sliding plates, but are held by two pins *t*. fig. 11, which fit into grooves *u*, fig. 10, in each side of the nut; by these means, the sliding plate can at any time be taken out by only unscrewing one of the brass sides from the groove *i*, without taking out the screw and nut. To make the grooves always fit their slides, the two pieces of brass *y y*, fig. 7, composing the sides of the groove, have elliptic holes for their screws *v*, so as to admit, when the screws are slackened, of being pushed inwards by the screws *w*, which work in a lump of metal cast with the part A A.

The larger lathes which this machinist uses in his manufactory, instead of being worked by the foot, as represented in fig. 1, are worked by hand; the wheel and fly-wheel which the men turn works by a strap on another wheel fixed to the ceiling, directly over it; on the axis of this wheel is a larger one, which turns another small wheel or pulley, fixed to the ceiling, directly over the mandrel of the lathe; and this last has on its axis a larger one which works the mandrel D, by a band of catgut. These latter wheels are fixed in a cast-iron frame, moveable on a joint; and this frame has always a strong tendency to rise up from the action of a heavy weight; the rope from which, after passing over a pulley, is fastened to the frame: this weight not only serves to keep the mandrel-band tight, when applied to any of the grooves therein, but always makes the strap between the two wheels on the ceiling fit. As it is necessary that the workman should be able to stop his lathe, without the men stopping who are turning the great wheel, there are two pulleys or rollers, (on the axis of the wheel over the lathe,) for the strap coming from the other wheel on the ceiling; one of these pulleys, called the *dead pulley*, is fixed to the axis with which it turns, and the other which slips round it, is called the *live pulley*; these pulleys are put close to each other, so that by slipping the strap upon the *live pulley*, it will not turn the axis; but if slipped on the other it will turn with it: this is effected by a horizontal bar, with two upright pins in it, between which the strap passes. This bar is moved in such a direction as will throw the strap upon the live pulley, by means of a strong bell-spring; and in a contrary direction it is moved by a cord fastened to it, which passes over a pulley, and hangs down within reach of the workman's hand; to this cord is fastened a weight, heavy enough to counteract the bell-spring, and bring the strap up to the dead pulley, to turn the lathe; but when the weight is laid upon a little shelf, prepared for the purpose, the spring will act and stop it.

There is some additional apparatus for cutting the teeth of wheels, in which the face of the mandrel D, fig 1, has seventeen concentric circles upon it, each divided into a different number of equal parts, by small holes. There is a thin stop, *x*, fig. 1, which moves round on a screw, fixed in the standard F: this stop made of thin steel is so fixed, that when turned up, and its point inserted to any of the divisions of the mandrel, it has a sufficient spring to keep it there: the wheel to be cut is fastened, by means of a chuck, to the screw *n*, and after it has been turned, and brought to the proper shape, the rest J is taken away, and the slide-tool substituted: a square bar is then put into the two holders, *b b*, fig. 7; this bar has two branches for holding the ends of a spindle, near one end of which is a pulley, and, instead of the circular saw commonly used, at the other are four chisels, fixed perpendicularly into the spindle, for cutting out the teeth; the pulley is turned with the intervention of several wheels to augment the velocity by the same great wheel as the lathe, with 7300 revolutions per minute; the mandrel is then fixed by the stop *x*, fig. 1, and the cutter advanced towards the wheel by the screw *c*, fig. 7. When it has cut that tooth, the cutter is withdrawn, and the mandrel turned to another division, and another tooth is cut again as before. At that part of the frame of the cutting spindle where the bar, fixed in the holders of the slide-tool, connects with the two branches, there is a joint, by which the cutting-spindle can be placed in an inclining position, for cutting oblique teeth, like those which work with an endless screw. The great velocity with which this spindle turns, soon generates, by friction and resistance, a degree of heat sufficient to expand it very sensibly; but this ingenious mechanist has judiciously compensated for it in his construction, by making the spindle so short as to play loosely in its sockets at the commencement of the motion; but after a few seconds the expansion causes the whole to fit together as it ought to do, and the work of cutting proceeds with accuracy, safety, and despatch.

As an improvement on the common lathe, Mr. Williamson, of Union-street, Lambeth, from many years' experience, has been induced to turn his attention to some mode of decreasing the friction, and lightening the labour. This he has at length accomplished by a simple addition to the machine that we shall immediately describe, first saying a few words on the construction of the common lathe.



The diameter of the wheel is about three feet; of the pulley, four or five inches; the line introduced under the one and over the other, commonly touches about $\frac{1}{8}$ of the pulley; and, therefore, to cause any body to revolve, whose diameter is the same as that of the pulley, or larger, a very thick line, about three-eighths of an inch diameter, or a line very tight, must be used, which in either case increases the friction, and of course materially increases the labour.

Now, the way in which Williamson works his lathe, so as to decrease the friction and lighten the labour, is by carrying the line over a second pulley, working on centres, and so placed as to leave the workman the power of tightening the line with facility, by means of a weight, according to the work he is engaged on. With this little addition, the workman uses a line only one-eleventh of an inch thick, which, applied according to the above figure, will carry, or cause to revolve, upon a nine-inch pulley, the nave of a waggon wheel, sixteen inches diameter, and eighteen inches long, (the dimensions in rough.) We mention this, to shew that it is suited to all sorts of work that can be done by the turner, and, in fact, enables him to do much heavier work than his strength would permit in the ordinary way.

Its advantages appear to be:—1. Decrease of friction. 2. That the same line can be employed for all the various speeds that are necessary. 3. That the effect of the various temperatures of the atmosphere upon the line is of no consequence, as, by means of the weight, it can be made to accommodate itself to the different changes. With catgut, which is generally used, this change of atmosphere, in the ordinary way, is found to occasion not only the frequent destruction of lines, but a great waste of time in repairing them.

The turner has generally upon his mandrel various-sized pulleys; yet it is no uncommon thing to find the line too slack upon one pulley, and too tight upon the next, when of necessity it must be dragged upon the larger, where it frequently breaks immediately, especially if the atmosphere is becoming more dense. Upon the same pulley the line can be used slack for small articles, and as tight as it may be found necessary for larger articles, by decreasing or increasing the weight, as occasion may require.

*Description of the Drawing.*—A, the wheel; B, the pulley; C, the additional pulley for the line to revolve on; D, the frame in which the additional pulley C works on centres; E, a joint on which the frame D works, to tighten the string by means of the weight H; F, screw centres for the pulley C; G G, pulleys for communication between the weight H and the frame D; H, the weight; I, section of the wheel A; K, section of the pulley B; L, centres and edge of the additional pulley C; M, a pin, on which, when the ring at the end of the line N is hung, the lathe is stopped.

Shortly after this account of Mr. Williamson's improvement made its appearance in the Mechanic's Magazine, a correspondent in that publication remarked, that this improvement, though extremely valuable, was susceptible of considerable simplification; and at the same time presented the following drawings of a plan, as calculated to prevent the line from chafing, and likewise obviate the necessity of changing the line for heavy work, as in the original plan.

Fig. 1 is the appearance of the lathe endwise; C represents one of two pieces, which are fixed to the back-bed of the lathe; F is a lever, moveable on the centre *o*, which lever has a piece cut out of the end, to admit the extra pulley D, which must, to allow the band to pass without rubbing, be placed so as to stand in winding with the pulley on the mandrel, as shewn by *d*, fig. 2; the lever F is furnished with hooks, on which the weight G is hung, according to the nature of the work. It would improve the plan, if the grooves in the mandrel-pulley, instead of being angular, were turned rather flat at the bottom. Fig. 2 will be readily understood, as the same letter denote the same parts as in fig. 1. A A are beds of the lathe C, the mandrel-pulley; B, the large wheel.

*Fig.* 1.

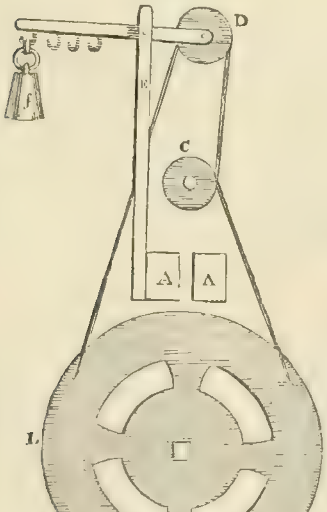
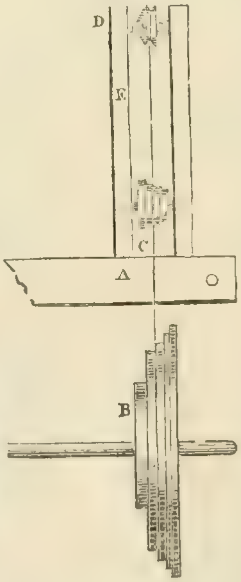


*Fig.* 2.



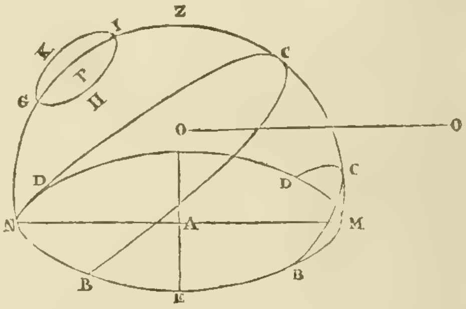
LATION, is sometimes used for translation or change of place.

LATITUDE, in Geography or Navigation, is the distance of a place from the equator, reckoned on an arch of the meridian, intercepted between its zenith and the equator.

*North* LATITUDE, is that which falls in the northern hemisphere; *viz.* between the equator and the north pole.

*South* LATITUDE, is that which falls in the southern hemisphere, or between the equator and south pole.

*Parallels* of LATITUDE, are small circles of the sphere supposed parallel to the equator; and are thus called because they shew the latitude of places by their intersection with the meridians, all places falling under the same circle being in the same latitude. The quadrant, or meridian, intercepted between the equator and either pole, is divided into ninety degrees, and numbered both ways from the equator to the poles; and the latitude of any place is equal to the measure of the arch intercepted between the equator and that place, and which is said to be north or south, according as it is situated towards the north or south pole. The latitude of a place, and the elevation of the pole above the horizon of that place, are terms frequently used indifferently the one for the other, being in fact equal to each other. To comprehend with precision the definitions now laid down, we shall have recourse to a diagram.



The circle M O N E represents the horizon, in the centre of which, and on the earth, an observer A is placed; B C D, B′C′D′ are portions of circles which the heavenly bodies seem to describe round the celestial pole (P), when we fancy they rise in the east and set in the west. Those whose distance from the pole is less than the arc P N, which marks the elevation of this point above the horizon, appear to describe entire circles, such as G K I H. N is the north point of the horizon: M the south; and consequently MN is the meridian line. The semi circle M Z N, the plane of which is supposed to be perpendicular to the horizon M E N O, and which passes through the points M N, is the celestial meridian, which divides the arcs B C D, B′ C′ D′, into two equal parts in the points C, C′. The point E is the east point of the horizon, and the point O the west point:—the heavenly bodies seem to move from E to O by transversing the meridian M Z N, which marks the middle of their course.

If we conceive the terrestrial globe we inhabit to be insulated, our station in the horizon and the axis of the earth being similar as in the diagram, it is evident that the horizon turning with us during the rotation of the globe, advances successively towards the stars situated in the direction of its motion, which consequently seems to be moving in an opposite direction to approach us. The plane M Z N of the meridian M N, perpendicular to the horizontal plane E N O M, turns also with this latter, and directs itself successively towards the same stars which are then in the middle of the course which they seem to describe above the horizon. When the western edge of the horizon touches a star, it appears to set, and ceases to be visible till the motion of the earth brings the eastern edge of the horizon towards it; because, during this interval, the visual rays which touch the earth pass above the star. This illustration accounts, in the most plain and simple manner, for the daily appearance and disappearance of the celestial bodies, by which circumstance the sun produces the alternation of day and night. All the motions alluded to, in the preceding definitions, are measured by their angles only, without any consideration of their absolute distances.

The *Zenith* is indicated by Z, being perpendicularly over the observer's head; and the *Nadir* is directly opposite.

If we suppose the plane B′ C′ D′ to be perpendicular to the axis of rotation, which passes from P through A, till it meets in the opposite hemisphere a point coinciding with P, this plane B′ C′ D′ will indicate the equator, all the points of which are at an equal distance from the poles P, P′. It follows from this equality, that, to a spectator placed on the equator, the poles are in the horizon; but as he advances towards either pole, *it* becomes elevated, while the other is depressed. And the angle P A N, which measures the elevation of the pole above the horizon, is equal to that which measures the angular distance of a place from the equator, estimated in the direction of the meridian. Also the height at which the equator appears above the horizon, is the complement of the angle Z A C[*]; for Z A N, C′ A P, being respectively right angles, if we subtract the common angle Z A P, the remainder Z A C′ = P A N. Hence if we suppose Z to be London 51° 31′ from the equator C′, the elevation of the pole is also 51° 31′. As soon then as the height of the pole above the horizon can be determined for any place, the angular distance of this place from the equator is known, or the number of parts of the meridian intercepted between this place and the horizon.

The circumpolar stars, which never set in those places where one of the poles is elevated above the horizon, determine this immediately; for since they appear to describe circles round the celestial pole, they are equally distant from it in every direction, and as they pass twice over the meridian during the diurnal revolution of the earth, namely, once above the pole, and once below it, if we measure their angular elevation at each of these positions, and take the mean of these two results, we shall obtain the elevation of the pole.

Let A be an observer on the earth, and let G H I K be the circle which a star describes round the point P; then by measuring the angle I A N when the star is on the meridian above the pole, and also the angle G A N when the same star is on the meridian below the pole; the angles I A P, G A P being equal, the angle P A N is the mean between I A N and G A N, and is equal, consequently, to half their sum. Moreover, if we take half the difference I A G of the angles I A N and G A N, measured between the star and horizon, we shall obtain the angle I A P, which will give the angular distance between the observed star and the celestial pole.

Thus, by measuring, for example, at London, during a long winter's night, the two meridian heights of the polar star (*a Ursæ Minoris*, having 88° 20′ 49″ declin. N.) we find that (*Ann.* 1820,)

| | |
|---|---|
| When it passes above the pole its altitude measures | 53° 10′ 11″ |
| And when it passes below the pole, it measures | 49° 51′ 49″ |
| The sum of which is | 103° 02′ 00″ |
| And their half | 51° 31′ 00″ |

Which will be the altitude of the pole above the horizon of London, or the distance of this city from the equator.

If, on the contrary, we subtract 49° 51′ 49″ from 53° 10′ 11″, we shall find for their difference 3° 18′ 22″, of which the half 1° 39′ 11″ will give the distance of the polar star from the pole (in 1820), which we thus find does not exactly occupy this point, but is yet very near to it.

The stars enable us to determine another position relative to any place where our former observation may have been made, namely, the *longitude* of that place: between the passage of the same star over any two meridians, a period of time elapses which is to the whole time of rotation as the angle made by these meridians is to two right angles; so that if the first interval can be measured, to compare it with the second, we may deduce the angle which the two meridians make with each other. This could be done, if we could indicate by a signal visible at the same time to the places under the two meridians the moment when a star appears on one of the meridians; because this instant being marked, a well-regulated watch would give the time which elapses between this transit and that of the same star over the other meridian.

If, for example, two observers, one at Portsmouth, R. N. Academy, and the other at Plymouth Garrison, having agreed to determine on the same day, the transit of the same star over the meridian of the place they inhabit, and that a signal given the moment when the star passes the meridian of Portsmouth Academy, could be visible at Plymouth garrison, about 12 minutes 6 seconds would elapse before the star would pass the meridian of Plymouth; and this interval being nearly the 120th part of the diurnal revolution of the earth, it follows that the plane of the meridian which passes over the Royal Navy Academy at Portsmouth, makes with that of the plane of the meridian which passes over the garrison of Plymouth, an angle which is nearly the 120th part of four right angles, or the measure of 3° 1′ 23″ according to actual observation. If for Portsmouth and Plymouth we substitute St. Paul's, London, and Sherburn Castle, the premises will give us one 360th part of the earth's diurnal revolution, or 4′ in time = 1° of the equinoctial. This second position of a place being thus determined, fixes its exact situation; for Sherburn, for instance, being, we shall say, in the same latitude with London, and 4′ later than it, its longitude is 1° west. So also Plymouth is 3° 1′ 23″ west of Portsmouth.—*From Dr. Jamieson's* CELESTIAL ATLAS.

LATITUDE, in Astronomy, as of a star or planet, is its distance from the ecliptic, being an arch of latitude of a circle of latitude, reckoned from the ecliptic towards the poles, either north or south. Hence, the astronomical latitude is quite different from the geographical, the former measuring from the ecliptic, and the latter from the equator, so that this latter answers to the declination in astronomy, which measures from the equinoctial. The sun has no latitude, being always in the ecliptic, but all the stars have their several latitudes, and the planets are continually changing their latitudes, sometimes north and sometimes south, crossing the ecliptic from the one side to the other; the points, in which they cross the ecliptic, being called the nodes of the planet, and in these points it is that they can pass over the face of the sun or behind his body, *viz.* when they come both to this point of the ecliptic at the same time.

*Circle* of LATITUDE, is a great circle passing through the poles of the ecliptic, and consequently perpendicular to it, like as the meridians are perpendicular to the equator, and pass through its poles.

LATITUDE of the *Moon, North ascending*, is when she proceeds from the ascending node towards her northern limit or greatest elongation.

LATITUDE, *North descending*, is when the moon returns from her northern limits towards the descending node.—LATITUDE, *South descending*, is when she proceeds from the descending node towards her southern limit.—LATITUDE, *South ascending*, is when she returns from her southern limit towards her ascending node: and the same is to be understood of the other planets.

*Heliocentric* LATITUDE, of a *Planet*, is its latitude or distance from the ecliptic, such as it would appear from the sun. This, when the planet comes to the same point of its orbit, is always the same, or unchangeable.—*Geocentric* LATITUDE, of a *Planet*, is its latitude as seen from the earth. This, though the planet be in the same point of its orbit, is not always the same, but alters according to the position of the earth in respect to the planet. The latitude of a star is altered only by the aberration of light, and the secular variation of latitude.

*Difference* of LATITUDE, is an arc of the meridian, or the nearest distance between the parallels of latitude of two places. When the two latitudes are of the same name, either both north or both south, subtract the less latitude from the greater, to give the difference of latitude; but if they are of different names, then their sum will be the difference of latitude.

LATTEN, iron plates tinned over, of which tea-canisters are made. *See* TINNING.

LAUGHTER, an affection peculiar to mankind, occasioned by something that tickles the fancy. In laughter, the eyebrows are raised about the middle, and drawn down next to the nose; the eyes are almost shut; the mouth opens and shews the teeth, the corners of the mouth being drawn back and raised up; the cheeks seem puffed up, and almost hide the eyes; the face is usually red; the nostrils are open; and the eye wet.

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[*] In referring to this diagram, the reader will understand that a right line is supposed to connect Z A, P A, C A, &c.

LAUNCH, a peculiar kind of boat. The principal superiority of the launch to the long boat, consists in being by its construction much fitter to undertake the cable, which is a very necessary employment in the harbours of the Levant sea, where the cables of different ships are fastened across each other; and frequently render this exercise extremely necessary.

Launch, is also the movement by which a ship or boat descends into the water; hence, to Launch.

To facilitate the operation of launching, and prevent any interruption therein, the ship is supported with two strong platforms laid with a gradual inclination to the water on the opposite sides of her keel, to which they are parallel. Upon the surface of this declivity are placed two corresponding ranges of planks, which compose the base of a frame called the cradle, whose upper part envelops the ship's bottom, whereto it is securely attached. Thus the lower surface of the cradle conforming exactly to that of the frame below, lies flat upon it, lengthways, under the opposite side of the ship's bottom, and as the former is intended to slide downwards upon the latter, carrying the ship along with it, the planes or faces of both are well daubed with soap and tallow.

The necessary preparations for the launch being made, all the blocks and wedges by which the ship was formerly supported are driven out from under her keel, till her whole weight gradually subsides upon her platform, above described, which are accordingly called the Ways. The shores and stanchions by which she is retained upon the stocks till the period arrives for launching, are at length cut away, and the screws applied to move her if necessary. The motion usually begins on the instant when the shores are cut, and the ship slides downwards along the ways, which are generally prolonged under the surface of the water to a sufficient depth to float her as soon as she arrives at the furthest end thereof.

When a ship is to be launched, the ensign, jack, and pendant are always hoisted, the last being displayed from a shaft erected in the middle of the ship. Ships of the first rate are commonly constructed in dry docks, and afterwards floated out by throwing open the flood-gates, and suffering the tide to enter, as soon as they are finished.

Launch *Ho*, is the order to let go the top-rope after the topmast is fidded.

LAUNDER, in Mineralogy, a name given in Devonshire, and other places, to a long and shallow trough which receives the powdered ore after it comes out of the box or coffer, which is a sort of mortar, in which it is powdered with iron pestles. The powdered ore, which is washed into the launder by the water from the coffer, is always finest nearest the grate, and coarser all the way down.

LAURUS Nobilis. Bay Tree. *Leaves and Berries.*—In distillation with water, the leaves of bay yield a small quantity of very fragrant essential oil; with rectified spirit, they afford a moderately warm pungent extract. The berries yield a larger quantity of essential oil: they discover likewise a degree of unctuosity in the mouth; give out to the press an almost insipid fluid oil; and on being boiled in water, a thicker butyraceous one, of a yellowish-green colour, impregnated with the flavour of the berry. An infusion of the leaves is sometimes drunk as tea; and the essential oil of the berries may be given from one to five or six drops on sugar, or dissolved by means of mucilages, or in spirit of wine.

LAURUS Sassafras. Sassafras Tree. *Bark.*—Its medical character was formerly held in great estimation; and its sensible qualities, which are stronger than any of the woods, may have probably contributed to establish the opinion so generally entertained of its utility in many inveterate diseases; for, soon after its introduction into Europe, it was sold at a very high price, and its virtues were extolled in publications professedly written on the subject. It is now, however, thought to be of very little importance, and seldom employed but in conjunction with other medicines of a more powerful nature. Dr. Cullen found, that a watery infusion of it taken *warm* and pretty largely, was very effectual in promoting sweat; but he adds, "to what particular purpose this sweating was applicable, I have not been able to determine." In some constitutions, sassafras, by its extreme fragrance, is said to produce headache; to deprive it of this effect, the decoction ought to be employed.

LAURUS, *Bay-tree*, a genus of the enneandria monogynia class and order of plants. Natural order of holoraceæ. There are 32 species. This genus consists of trees or shrubs; leaves mostly entire, in a few nearly opposite, commonly perennial, as in most trees of the torrid zone. L. nobilis, common sweet bay, grows from twenty to thirty feet in height; it has large evergreen leaves, of a firm texture, with an agreeable smell, and an aromatic bitterish taste; flowers dioecius, or male and female on different trees, in racemes shorter than the leaves, of an herbaceous colour; corollas four-petalled in the male flowers; stamens from eight to twelve; berry superior, of a dark purple colour, almost black; it is a native of the southern parts of Europe and Asia. L. persea, alligator, or avocado pear of the West Indies, is about thirty feet in height; the fruit is the size of one of our biggest pears, enclosing a large seed with two lobes. It is held in great esteem in the West Indies; the pulp is of a pretty firm consistence, and has a delicate rich flavour. L. cinnamomum, or cinnamon-tree, is a native of Ceylon. It has a large root, and divides into several branches, covered with a bark, which on the outer side is of a grayish brown, and on the inside has a reddish cast. The body of the tree, which grows to the height of twenty or thirty feet, is covered, as well as its very numerous branches, with a bark, which at first is green and afterwards red. The leaf is longer and narrower than the common bay-tree; and it is three-nerved, the nerves vanishing towards the top. The flowers are small and white, and grow in large bunches at the extremity of the branches. The fruit is shaped like an acorn, but is not so large.

LAVA, the production of Ætna, Vesuvius, Hecla, and other volcanoes, is of a grayish colour passing to green: it is spotted externally, and occurs porous, carious, or vesicular. Its lustre is vitreous, more or less glistening. It is moderately hard, brittle, easily frangible, and light. It generally attracts strongly the magnetic needle. It is easily fusible into a black compact glass. It frequently encloses other fossils, especially crystals of felspar, augite, hornblende, and leucite. *See* Volcanoes.

LAVENDER Leaves. Lavender has been an officinal plant for a considerable time, though we have no certain accounts of it given by the ancients. Its medical virtue resides in the essential oil, which is supposed to be a gentle corroborant and stimulant, of the aromatic kind; and is recommended in nervous debilities, and various affections proceeding from a want of energy in the animal functions.

LAYING the Land, the state of motion which increases the distance from the coast, so as to make it appear lower and smaller; a circumstance which evidently arises from the intervening convexity of the surface of the sea. It is used in contradistinction to raising the land, which is produced by the opposite motion of approach towards it.

*To* Lay-in *off a Yard*, to come from the yard-arms towards the mast, so as to quit it at the rigging. Laying *out on a Yard*, is to go out towards the yard-arms.

LAY-MAN, among Painters, a small statue, whose joints are so formed, that it may be put into any attitude, for the purpose of adjusting the drapery of figures.

LAZARETTO, a building, or vessel, fitted up and appointed for the performance of quarantine, in which all persons are confined who are suspected to have come from places infected with the plague.

LAZULITE, in Mineralogy, is of a deep smalt blue: it occurs disseminated in fine grains, or masses, of the size of a hazel-nut.

LEAD, a white metal of a considerably blue tinge, very soft and flexible, not very tenacious, and consequently incapable of being drawn into fine wire, though it is easily extended into thin plates under the hammer. Its specific gravity is 11·35. It melts at 612 deg. In a strong heat it boils, and emits fumes;

during which time, if exposed to the air, its oxidation proceeds with considerable rapidity. Lead is brittle at the time of congelation. In this state it may be broken to pieces with a hammer, and the crystallization of its internal parts will exhibit an arrangement in parallel lines. Lead is not much altered by exposure to air or water, though the brightness of its surface, when cut or scraped, very soon goes off. It is probable that a thin stratum of oxide is formed on the surface, which defends the rest of the metal from corrosion. Most of the acids attack lead. The sulphuric does not act upon it, unless it be concentrated and boiling. Nitric acid acts strongly on lead. Muriatic acid acts directly on lead by heat, oxidizing it, and dissolving part of its oxide. The acetic acid dissolves lead and its oxides, though probably the access of air may be necessary to the solution of the metal itself in this acid. White lead, or ceruse, is made by rolling leaden plates spirally up, so as to leave the space of about an inch between each coil, and placing them vertically in earthen pots, at the bottom of which is some good vinegar. This, like all the preparations of lead, is a deadly poison. The common sugar of lead is an acetate; and Goulard's extract, made by boiling litharge in vinegar, a subacetate. The power of this salt, as a coagulator of mucus, is superior to the other. If a bit of zinc be suspended by brass or iron wire, or a thread, in a mixture of water and the acetate of lead, the lead will be revived, and form an arbor Saturni. Oils dissolve the oxide of lead, and become thick and consistent; in which state they are used as the bases of plasters, cements for water-works, paints, &c. Sulphur readily dissolves lead in the dry way, and produces a brittle compound, of a deep grey colour and brilliant appearance, which is much less fusible than lead itself. Lead unites with most of the metals. Two parts of lead, and one of tin, form an alloy more fusible than either metal alone: this is the solder of the plumbers. Bismuth combines readily with lead, and affords a metal of a fine close grain, but very brittle. A mixture of eight parts bismuth, five lead, and three tin, will melt in a heat which is not sufficient to cause water to boil. All the oxides of lead are easily revived with heat and carbon. Oxygen and lead combine together in different proportions. If the nitre of lead be dissolved in a precipitation produced by potash, the precipitate, when dried, will become the yellow protoxide. If it be somewhat vitrified, it constitutes litharge; and combined with carbonic acid, it becomes white lead or ceruse. This protoxide forms the pigment massicot. Massicot exposed for about 48 hours to a great heat, becomes red lead, or minium. Salts of lead have the peroxide for their base. They yield, when placed on charcoal by the blow-pipe, a button of lead. They dissolve in water, and yield a colourless solution of an astringent sweetish taste. Lead, alloyed with an equal weight of tin, ceases to be acted upon by vinegar. Acetate and subacetate of lead have a good effect, as external applications, for inflamed surfaces, burns, scrofulous sores, and as eye washes. Lead taken internally is very injurious: hence the diseases to which painters are liable. Litharge, dissolved in wines, to give them a sweet taste, is very mischievous. Sulphuretted hydrogen will cause it to throw down a black precipitate.

**Lead**, *Black*. *See* Black Lead.

**LEAD, Sugar of.** A salt, denominated from its composition, by modern chemists, acetate of lead, is much used in calico printing and other manufactures.

**Lead**, *Ores of*. Ores of lead occur in great abundance in almost every part of the world. They are generally in veins; sometimes in siliceous rocks, sometimes in calcareous rocks. Nearly all the lead in commerce is obtained from galena, which is a compound of sulphur and lead.

**LEAD**, an instrument for discovering the depth of water; it is composed of a large piece of lead, from seven to eleven pounds weight, and is attached, by means of a strop, to a long line called the lead-line, which is marked at certain distances to ascertain the fathoms.

*To Heave the* Lead, is to throw it into the sea in a manner calculated to produce the desired effect. *Deep-Sea* Lead, a lead of a larger size, being from 25 to 30 pounds weight, and attached to a much longer line than the former, which is called a hand-lead.

**LEADSMAN**, the man who heaves the lead.

**LEADING Wind**, a free or fair wind, and is used in contradistinction to a scant wind.

**LEAGUE**, a measure of length, containing more or less geometrical paces, according to the different usages and customs of countries. A league at sea contains three thousand geometrical paces, or three English miles. The French league sometimes contains the same measure, and in some parts of France it consists of three thousand five hundred paces: the mean or common league, consists of two thousand four hundred paces, and the little league of two thousand.—Seventeen Spanish leagues make a degree, or sixty-nine and a half English statute miles. The Dutch and German leagues contain each four geographical miles. The Persian leagues are equal to four Italian miles, pretty near to what Herodotus calls the length of the Persian parasang, which contains thirty stadia, eight of which make a mile.

**LEAK**, a chink or breach in the deck, sides, or bottom of a ship, through which the water passes into her hull. When a leak first commences, a vessel is said to have sprung a leak.

**Leakage**, is the quantity which runs out of a cask through a leak.

**Leaky**, the state of a ship when abounding with leaks; also of a cask which suffers the liquor within it to run out.

**LEASE**, a conveyance of lands or tenements generally in consideration of rent or other annual recompense for life, for years, or at will, but always for a shorter term than the lessor has in the premises, otherwise it partakes more of the nature of an assignment.

All leases of lands, except leases not exceeding three years, must be made in writing, and signed by the parties themselves, or their agents duly authorized, otherwise they will operate only as leases of will. If a lease is but for half a year, or a quarter, or less time, the lessee is respected as a tenant for years. To constitute a good lease, there must be a lessor not restrained from making the lease to the extent for which it is granted; a lessee capable of receiving it; and the interest demised must be a demisable interest, and be sufficiently and properly described. If it is for years, it must have a certain commencement and termination; it is to have all the usual ceremonies, as sealing, delivery, &c. and there must be an acceptance of the thing demised.

Leases for life must not be made to commence at a future day, and there must be a livery of seisin. They mustnow be stamped as a lease, to be valid; and any form of writing will constitute a lease, provided it contains words of present demise, or actual letting; but if it be only an agreement to let, it conveys no immediate title in law, but only an equitable right to have a lease, or to sue at law for not making one. If a lease is made to one for years, and at the same time to another for a longer time, the last lease is not void, but shall take effect after the first expires. A tenant for life can in general only grant a lease to insure during his life; but sometimes a power is annexed to such an estate to grant leases for a specified time, and under particular limitations, all which must be strictly complied with, or the lease is void. An infant may make a lease: but may set it aside when come of age, and the court of chancery is empowered to grant leases for idiots, lunatics, infants, and married women.

The rent must be reserved to the executor or the heir of the lessor, according as his estate is real or personal. Lessees are bound to repair, unless the contrary is specified, and although if the house is burnt by accident they are not bound to rebuild yet they must, if the fire be by negligence; and if there is a covenant to pay rent, and a covenant to repair, except in case of fire, yet rent is payable, although the house is not rebuilt by the landlord. If there is a covenant not to assign, lease, or under-let, without license of the landlord, the tenant cannot even grant an under lease. Upon a lease at will, six months' notice to quit must generally be given by either party, to terminate on the same day in the year when the lease commenced. Leases made by spiritual persons of their church lands, must be conformable to the statute called the Enabling and Disabling statutes. The tenant may, at the trial of an ejectment, insist upon his notice to quit being sufficient, although he made no objection when it was served.

**LEATHER**, *The Manufacture of.* The leather tanned in England consists of butts, hides, and skins. Butts are manufactured out of the strongest skins of oxen. The hides are laid in heaps two days in summer, and six in winter; they are then hung up on poles, in a close room or smoke-house, exposed to the heat of a smouldering fire of wet tan. Afterwards the hair is scraped off, and they are thrown into a pool of water, and again spread on a wooden beam and carefully scrubbed. They are now put into pits of strong bark ooze; again into a strong solution of vitriolic acid; next they are spread in a pit with ground bark strewed between each, where they lie six weeks, and the decayed bark and liquor being drawn out of the pit, it will precipitate. Isinglass is used for this purpose, being entirely composed of gelatine. And here it may be observed, that this is the mode of ascertaining the quantity of tanning principle in any vegetable substance, and consequently how far they may be used as a substance for hard oak. The hides being prepared in the usual way, are immersed for some hours in a weak tanning lixivium of two degrees' strength. To obtain this, the latter portions of the infusions are set apart, or else some of that which has been partly exhausted by use in tanning. The hides are then to be put into a stronger lixivium, where in a few days they will be brought to the same degree of saturation with the liquor in which they are immersed. The strength of the liquor will thus be considerably diminished, and must therefore be renewed. When the hides are by this means perfectly tanned, they are to be removed, and slowly dried in the shade. The length of time necessary to tan leather completely, according to the old process, is a great inconvenience; and there is no doubt that it may be much shortened by following the new method; but the leather so tanned has not been so durable as that which has been formed by the slower process.

Sir H. Davy, in treating "on the Constituent Parts of Astringent Vegetables," thus speaks of tanning:—In considering the relation of the different facts that have been detailed, to the processes of tanning and of leather-making, it will appear sufficiently evident, that when skin is tanned in astringent infusions that contain, as well as tannin, extractive matters, portions of these matters enter with the tannin, into chemical combination with the skin. In no case is there any reason to believe that gallic acid is absorbed in this process; and M. Seguin's ingenious theory, of the agency of this substance, in producing the de-oxygenation of skin, seems supported by no proofs. Even in the formation of glue from skin, there is no evidence which ought to induce us to suppose that it loses a portion of oxygen; and the effect appears to be owing merely to the separation of the gelatine from the small quantity of albumen with which it was combined in the organized form, by the solvent powers of water. The different qualities of leather made with the same kind of skin, seem to depend very much upon the different quantities of extractive matter it contains. The leather obtained by means of infusion of galls, is generally found harder, and more liable to crack, than the leather obtained from the infusion of barks; and in all cases it contains a much larger proportion of tannin, and a smaller proportion of extractive matter. When skin is very slowly tanned in weak solutions of the barks, or caoutchouc, it combines with a considerable proportion of extractive matter; and in these cases, though the increase of weight of the skin is comparatively small, yet it is rendered perfectly insoluble in water, and is found soft, and at the same time strong. The saturated astringent infusions of barks contain much less extractive matter, in proportion to their tannin, than the weak infusions; and when skin is quickly tanned in them, common experience shews that it produces leather less durable than the leather slowly formed. Besides, in the case of quick tanning by means of infusions of barks, a quantity of vegetable extractive matter is lost to the manufacturer, which might have been made to enter into the composition of his leather. These observations shew, that there is some foundation for the vulgar opinion of workmen, concerning what is technically called the *feeding* of leather in the slow method of tanning; and though the processes of the art may in some cases be protracted for an unnecessary length of time, yet, in general, they appear to have arrived, in consequence of repeated practical experiments, at a degree of perfection which cannot be very far extended by means of any elucidations of theory that have as yet been known.

*Currying.* The art of currying consists in rendering tanned skins supple, of uniform density, and impregnating them with oil, so as to render them in a great degree impervious to water. The strong and thick hides are employed for making the soles of boots and shoes, and these are rendered fit for their several purposes by the shoemakers after they are tanned: but such skins as are intended for the upper leathers and quarters of shoes, for the legs of boots, for coach and harness leather, saddles, and other things, must be subject to the process of currying. These skins, after coming from the tanners, have fleshy fibres on them. They are well soaked in common water, then taken out, and stretched upon a very even wooden horse; where with a paring knife all the superfluous flesh is scraped off, and they are again put into a pit or vessel to soak. After the *soaking* is completed, the currier takes them again out of the water, and having stretched them out, presses them with his feet, or a flat stone fixed in a handle, to make them more supple, and to press out all the filth that the leather may have acquired in tanning, and also the water it has absorbed in soaking. The skins are next to be *oiled*, to render them pliant and impervious to wet. After they are half dried, they are laid upon tables, and first the grain side of the leather is rubbed over with a mixture of fish-oil and tallow; then the flesh side is impregnated with a large proportion of oil. After having been hung up a sufficient time to dry, they are taken down and rubbed, pressed, and folded, and then spread out, when they are rolled with considerable pressure upon both sides with a fluted board fastened to the operator's hand by a strap; by this means, and by repeating the rolling, a grain is given to the leather. After the skins are curried, it may be required to colour them. The colours usually given to them are black, white, red, green, yellow, &c. If the skins are to be blacked, the process varies according to the side of the skin to be coloured. Leather that is to be blacked on the flesh side, which is the case with most of the finer leather intended for shoes, and boots, is coloured with a mixture of lamp black, oil, and tallow rubbed into the leather. And what is to be coloured on the grain side is done over with chamber-lie, and then with a solution of sulphate of iron, which turns it black.

*Water-proof Leather.* To render leather water-proof, the following method is adopted: Take a small pipkin or earthen vessel, and put in it three ounces of spermaceti, to be melted over a slow fire; then take three-quarters of an ounce of caoutchouc, or Indian rubber, cut into thin slices; and the spermaceti will completely dissolve this substance. Add eight ounces of tallow, two ounces of hog's lard, and four ounces of amber varnish. The boots or shoes must be rendered dry and warm, and this cement well rubbed in, three or four times, with a brush.

*Morocco Leather* is made of the skins of goats, tanned and dyed in a peculiar manner by the Turks. This process, originally invented in the kingdom of Morocco, has given rise to the name of Morocco leather. *English* Morocco leather, used so largely for coach-linings, pocket-books, and the best kind of book-binding, is prepared from sheep-skins.

*Shagreen* is a sort of rough leather, prepared from the skin of the spotted shark. The skin of the fish is first stripped, then extended on a table, and covered with bruised mustard-seed: it is thus exposed to the weather for several days, and afterwards tanned. The best shagreen imported from Constantinople, is of a brownish cast, and very hard; but, when immersed in water, it becomes soft and pliable; and may be dyed to any colour. It is often counterfeited, by preparing Morocco leather in the same manner as the skin of the fish. This fraud may be detected by the surface of the spurious manufacture peeling or scaling off, while that of the genuine article remains perfectly sound. Shagreen is employed principally in the manufacture of cases for mathematical instruments.

*Chamois*, is a kind of leather, either dressed in oil, or tanned, and much esteemed for its softness and pliancy. It is prepared from the skin of the *chamois*, a wild goat, on the mountains of Dauphiny, Savoy, Piedmont, and the Pyrenees. Besides the softness and warmth of the leather, it has the faculty of bearing soap without hurt. The true chamois leather is very frequently counterfeited with common goat, kid, and even sheep skin.

*French mode of rendering Leather, Canvass, Linen, &c. Water-proof.* The following substances are first well ground and mixed together, *viz.* 1½ lb. of the acetate of lead (sugar of lead,) and 1½ lb. of very finely powdered pumice stone; these are then boiled in 100 gallons of the best linseed oil, over a gentle fire, that the oil may not be burned. The liquid should be kept boiling, until it becomes of such a consistence, that after being mixed with a third part of its weight of pipe-clay, it should be of the thickness of molasses. It is then left to clear itself, and afterwards passed through a fine lawn sieve. About 10 pounds of pipe-clay is then to be ground with a solution of the best glue, and so mixed as to be of the consistence of lard; to this mixture is to be added the varnish by degrees, mixing and stirring it well at every addition, with a spatula of wood, until it has become perfectly fluid. The colour is then added, consisting of 1¼ lb. of calcined umber, and 1½ lb. of white lead ground in oil. In order to apply it, the linen is stretched over a frame of wood, and the composition spread by means of a broad spatula, about 3 inches wide and 9 inches long. The frame is then inverted, and the composition applied on the other side of the cloth; it is allowed to remain for a week on the frame to dry, and then taken off for use. The cloth so prepared is used for riding cloaks, and as covers for carriages, &c. The same composition is applied to leather and skins, but to produce a glossy brilliant appearance, a varnish is employed, consisting of 5 lb. of the oil varnish, as before mentioned, and an equal weight of clear resin, heated together over a fire until the resin is dissolved; to these are added 2 lbs. of oil of turpentine, with which has been ground some colour, to give it the required tint, and cleared of all impurities by passing through a fine lawn sieve. This varnish is laid on with a brush, and when quite hard is rubbed over with pumice stone and water, and afterwards well washed. Two or three coats of this varnish are given to it, each coat being well dried before another is laid on, by which is produced a varnish of such brilliancy as to rival the best japan.

The following recipe, although it will not render boots and shoes entirely water-proof, will make them much more impervious to wet, more durable and pliable, and prevent their cracking:—Take one pint of boiled linseed oil, two ounces of bees-wax, two ounces of spirits of turpentine, and one ounce of Burgundy-pitch, melted carefully over a slow fire. With this composition, rub the soles and upper leathers, when new, with a small piece of sponge, in the sun, or at a distance from the fire; rub them as often as they become dry, until the leather is fully saturated.

*Another Method.* Mix equal parts of mutton-fat, bees-wax, and sweet-oil together, in a small gallipot, and heat them over the fire till melted; then, after the mixture has cooled a little, apply it to the shoes plentifully, particularly about the welt and seams, and that will render them entirely water-proof.

LEDGE, a long ridge of rocks near the surface of the sea.

Ledges, small pieces of timber placed athwart ships, under the decks, in the intervals between the beams.

LEE, an epithet to distinguish that half of the horizon to which the wind is directed from the other part whence it arises, which latter is accordingly called, to windward. This expression is chiefly used when the wind crosses the line of a ship's course: so that all on one side of her is called, to windward; and all on the opposite side, to leeward; and hence,

*Under the* Lee, implies farther from that part of the horizon from whence the wind blows, as, Under the lee of the land, *i. e.* at a short distance from the shore which lies in the direction of the wind. This phrase indicates the situation of a vessel anchored or sailing near the weather shore, where there is always smoother water than at a great distance from it. To lay a ship by the lee, or to come up by the lee, is to bring her so that all her sails lie flat against her masts and shrouds, and that the wind may come right upon her broadside.

Lee *Boards*, strong frames of plank affixed to the sides of flat-bottomed vessels, such as river barges, &c. which draw but little water; these, by being let down into the water when the vessel is close-hauled, prevent her from falling leeward. Lee *Fangs*, are ropes reeved into the cringles of a yacht or hoy's sails. *The* Lee *Gage*, implies further from the point whence the wind blows than another vessel. *Take care of the* Lee *Hatch*, is a word of command to the man at the helm, to take care that the ship do not go to the leeward of her course. Lee *Lurches*, the sudden and violent rolls which a ship often takes to leeward in a high sea, particularly when a large wave strikes her on the weather side.

A Lee *Shore*; a ship is said to be on a lee-shore, when she is near the land, with the wind blowing right upon it.

Lee *Side*, all that part of a ship or boat which lies between the mast and the side farthest from the direction of the wind; or that half of a ship which is pressed down towards the water by the effort of the sails, as separated from the other half by a line drawn through the middle of her length; that part of the ship which lies to the windward of this line is accordingly called the weather side. Thus, if a ship sail southward with the wind at east, then is her starboard or right side the lee-side; and the larboard or left, the weather-side.

Lee *Tide*, is a tide running in the same direction that the wind blows, and is directly contrary to a tide under the lee which implies a stream in an opposite direction to the wind.

*To* Leeward, denotes towards that part of the horizon which lies under the lee, or whither the wind blows.

Leeward *Ship*, is one that is not fast by the wind, or which does not sail so near the wind, nor make so good way, as she should; or which is much to leeward of her course, when sailing close-hauled.

Lee *Way*, or *Leeward Way*, is the lateral movement of a ship to the leeward of her course, or the angle which the line of her way makes with her keel when she is close-hauled. This movement is produced by the mutual effort of the wind and sea upon her side, forcing her to leeward of the line upon which she appears to sail; and in this situation her course is necessarily a compound of the two motions by which she is impelled. All ships are apt to make some lee-way; so that in casting up the log-book, something must be allowed for lee-way. But the lee-way made by different ships, under the same circumstances, will be different; and even the same ship, with different lading, and having more or less sail on board, will make more or less lee-way. The ordinary rules of allowing for it, as given by Mr. John Buckler to Mr. William Jones, who first published them about the year 1702, are these:—1. When a ship is close-hauled, has all her sails set, the water smooth, and a moderate gale of wind, she is then supposed to make little or no lee-way. 2. Allow one point when it blows so fresh that the small sails are taken in. 3. Allow two points, when the topsail must be close reefed. 4. Allow two points and a half when one topsail must be handed. 5. Allow three points and a half when both topsails are to be taken in. 6. Allow four points when the fore-course is handed. 7. Allow five points when trying under the main sail only. 8. Allow six points when both main and fore courses are taken in. 9. Allow seven points when the ship tries a-hull, or all sails are handed. When the wind has blown hard in either quarter, and shifts across the meridian into the next quarter, the lee-way will be lessened. But in all these cases respect must be had to the roughness of the sea with the trim of the ship; and hence the mariner will be able to correct his course.

LEECHES, *Water Snails.* To apply leeches effectually, the skin should be soft, and if lotions have been used, the skin must be cleanly washed, and the leeches will bite very readily when they are fresh and hungry. The best mode of applying them is to let the leech crawl on a dry piece of linen for a little time; or better, if it have been kept in a vessel without water for some time beforehand, then to take it in a bit of soft linen between the thumb and finger, and when it projects its pointed mouth between the folds of the linen, to direct it to the spot intended for it to act on. In this way the leech will generally fasten at the first touch, and it will at all events fasten more readily, since it is prevented from covering the skin with slime, and thus sheathing it from its own bite and that of other leeches. The most skilful appliers of leeches use this method, and they gain celebrity by thus throwing them on the part, as some of them express it.

Another way is, to put the leeches into a wine glass or pill-box, and then to invert the glass or box on the proper part. This method does not answer when the leeches are not lively, for they will fix on the sides of the vessel, so as not to be again made to touch the skin. This difficulty may generally be obviated by putting more leeches into the vessel or vessels than are wished to be applied, and removing them when the proper number have adhered.

In cases of difficulty, it is often advantageous to cover the part with cream or milk; or better, to touch the head of the leech with a drop of vinegar; or to make small incisions in the skin (of the operator perhaps, if the patient be a sleeping child) by means of a lancet: or, if one leech have adhered, to take it off again, and use the blood to entice others to do likewise. Mr. Thomson says, in the London Dispensatory, that a leech may certainly be made to bite on any assigned spot, by putting it into a quill which is open at both ends, and after placing the end containing the leech's head on the part, stopping up the other end by means of the finger. This information is valuable, at least if the plan prove generally successful, in cases where leeches are required close to an important part, as near the eye or on the gums, &c.; but it is to be feared that the quill would be as likely to fail as the common leech-glass, both being used on the same principle; and the latter being confessedly an ineffective instrument.

The pain of biting generally ceases in a short time after the leech has adhered; but if the patient be so placed as that the leech hangs as it were from the point of adhesion, the pain is in some individuals increased, and continues till the leech falls off. Leeches should not remain on the part for more than ten or fifteen minutes; if they do not then fall off, it will be found that they have been sluggish, and are not full, and the same thing will be shewn by the want of that vermicular motion on the neck of the leech, which is so perceptible when it draws vigorously. In these cases it may often be made more active by touching its head with vinegar.

As it sometimes happens that leeches, when indolent, will thus remain on the part for hours, it is better to remove them when they are disposed to suck. This may be done by the application of a very little salt to their heads, and as the after bleeding is generally more advantageous than the drawing of the leech itself, very little loss is sustained by removing them before they are filled with blood.*

*The Treatment of Leeches after their Removal from the Skin.*—Great waste is occasioned by the unskilfulness in attending to leeches after they fall off. By proper care they may be made to act again and again; for, when it is considered that blood is the natural food of the leech, it must follow, that some fault in our treatment causes their death, and not their having made a hearty meal on food that is natural to them. It may happen, indeed, that the blood in certain states of disease acts as a poison, and destroys them; many persons having stated that they fall off dead, in some cases, before any application is made to them: but this is at least problematical, and perhaps unlikely. The common practice of covering them with salt is almost always destructive; and, even by sprinkling a small quantity on their bodies, if death do not follow, it generally happens that the leech is blistered by the salt, and made incapable of acting again for a considerable time. Squeezing out the blood is better than the application of salt in any form; but the best mode is to touch them with vinegar, which, if sparingly applied, will make them vomit, so that they may be re-applied again immediately, even to the third or fourth time, or, by returning them into clean water, be ready for another occasion. When leeches are treated in this way, and especially if they be allowed to keep, perhaps, a fourth part of the blood which they have swallowed, they are not only capable of acting repeatedly, but, in skilful hands, may be made to grow to an immense size.

Under one gentleman's care, a set of leeches were in this way preserved for a great length of time, and at last they grew to the length of nearly eight inches. It was want of care that destroyed them, even after all this. These leeches were not once emptied of their blood, and yet they were often used again at an interval of only a few days. We understand it is the practice of some surgeons, when leeches have been scarce, and it has been considered requisite to take a large quantity of blood from a patient, to cut off the tail of the leech, when it has nearly filled itself; the creature keeps on sucking to fill itself, and appears to be unconscious of its being employed merely as a funnel or a spout.

**Leeches**, the borders or edges of a sail, which are either sloping or perpendicular; those of the square-sails, *i.e.* the sails whose tops and bottoms are parallel to the deck, or at right angles with the mast, are denominated from the ship's side, as the starboard-leech of the main-sail, the lee-leech of the fore-topsail; but the sails which are fixed obliquely on the masts have their leeches named from their situation with regard to the ship's length, as the fore-leech of the mizzen, the after-leech of the jib, &c.

**Leech** *Lines*, ropes fastened to the middle of the leeches of the mainsail and foresail, and communicating with blocks under the opposite sides of the top, whence they pass downwards to the deck, serving to truss those sails up to the yards. *Harbour* **Leech** *Lines*, ropes made fast at the middle of the topsail yards, then passing round the leeches of the topsails, and through blocks upon the topsail-tye, serving to truss the sails very close up to the yard, previous to their being furled in a body. **Leech** *Rope*, a name given to that part of the bolt-rope to which the border or edge of a sail is sewed. In all sails whose opposite leeches are of the same length, it is terminated above by the earing, and below by the clue.

**LEET**, a little court held within a manor.

**LEGION** in Roman antiquity, a body of foot, which consisted of ten cohorts or battalions, each cohort consisting of six centuries, commanded by a centurion, and when full, a century was 100 men, but the numbers were often incomplete, particularly during a campaign.

**LEGISLATOR**, a lawgiver, or a person who establishes the policy and laws of a state. Such was Moses, among the Jews; Lycurgus, among the Lacedæmonians, &c.

**LEMMA**, in Mathematics, denotes a previous proposition, laid down in order to clear the way for some following demonstration, and prefixed either to theorems, in order to render their demonstration less perplexed and intricate, or to problems, to make their solution more easy and short. Thus, to prove a pyramid one-third of a prism or parallelopiped of the same base and height with it, the demonstration of which in the ordinary way is difficult and troublesome, this lemma may be premised, which is proved in the rules of progression, *viz.* that the sum of a series of square numbers in arithmetical progression, beginning from 0, as 1, 4, 9, 16, 25, 36, &c. is always subtriple of the sum of as many terms, each equal to the greatest; or, is always one-third of the greatest term multiplied by the number of terms.

**LEMONS**, Salt of, used to remove ink-stains from linen, is the native salt of sorrel, the super-oxalate of potash. The effect is produced by the oxalic acid dissolving with facility the oxide of iron in the ink, on the combination of which with the tannin and gallic acid, the colour depends; while, at the same time, it can be used without any risk of injury to the cloth, on which it has no effect.

**LEMURES**, in Antiquity, spirits or hobgoblins; restless ghosts of departed persons, who return to terrify and torment the living. These are the same with larvæ, which the ancients imagined to wander round the world, to frighten good people and plague the bad. For which reason, they had at Rome lumeria, or feasts, instituted to appease the manes of the defunct. *See* Lares.

**LENGTHENING**, the operation of cutting a ship down across the middle, and adding a certain portion to her length. This is performed by sawing her planks asunder in different parts of her length, on each side of the midship frame, to prevent her from being weakened too much in one place. The two ends are then drawn apart to a limited distance, which must be equal to the proposed addition of length. An intermediate piece of timber is next added to the keel, upon which a sufficient number of timbers are erected to fill up the vacancy produced by the separation. The two parts of the keelson are afterwards united by an additional piece, which is scored down upon the floor timbers; and as many beams as may be necessary are fixed across the ship in the interval. Finally, the planks of the side are prolonged so as to unite with each other, and those of the ceiling refitted in the same manner, by which the whole process is completed.

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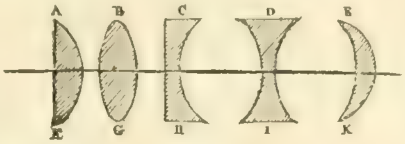
* According to one gentleman's experiments, the largest leech is not more than a drachm heavier when full, than before application. If so, small ones cannot draw away more than half a tea-spoonful of blood.

**LENS**, a piece of glass or other transparent substance, having its two surfaces so formed that the rays of light in passing through it have their direction changed, and made to converge or diverge from their original parallelism, or to become parallel after converging or diverging. Lenses receive particular denominations according to their form; as *convex*, *concave*, *plano convex*, *plano concave*, lenses, and *meniscuses*.

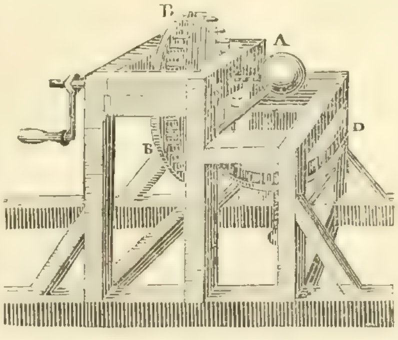
*Convex* **Lens**, is one which is thickest in the middle. If only one side is convex and the other plane, it is called a *plano convex lens*, such is A F, in the following figure; but if it be convex on both sides, it is called a *convexo convex*, or *double convex lens*, as B G.



*Concave* **Lens**, is that which is thinnest in the middle; but it is also divided into *plano concave* and *concavo concave*, as in the former case; such are two lenses C H, D I.

And when the lens is concave on one side and convex on the other, it is called a *meniscus*, as E K, in the above figure. In every lens the right line perpendicular to the two surfaces is called the *axis* of the lens; the points where the axis cuts the surface, are called the *vertices* of the lens; also the middle point between them is called the *centre*, and the distance between them the *diameter*. Some confine the term lenses to such as do not exceed half an inch diameter, those that exceed this being termed *lenticular glasses*.

Lenses are either blown or ground. Blown *Lenses*, are small globules of glass melted in the flame of a lamp by a blow-pipe, or otherwise. Ground *Lenses*, are such as are ground to the required form by means of machinery for this purpose.



The **Lens** *Grinding Machine* is of varied form and construction. This figure represents one of these machines, so contrived as to turn a sphere at one and the same time on two axes, cutting each other at right angles, and producing the segment of a true sphere merely by turning round the wheels without any care or skill of the workman. A is a globe covered with cement, on which are fixed the pieces of glass to be ground; this globe is fastened to the axis, and turns with the wheel B. C is the brass cup that polishes the glass. This is fastened to the axis, and turns with the wheel D. The motion of the cup C, therefore, is at right angles to the motion of the globe A; whence it follows demonstrably, that the pieces of glass ground by this double motion must be formed into the segments of spheres.

**LENT**, a solemn time of fasting in the Christian church, observed as a time of humiliation before Easter, the great festival of our Saviour's resurrection.

**LEO Minor**, the *Little Lion*, it has been said, owes its place in the heavens to the fable of Hercules killing the Nemæan lion. This is erroneous, for Leo Minor was composed out of the *stella informes* of the ancients. In the Egyptian calendar we find the sign Leo to contain the figures of two lions, and the head of a third. The Little Lion is a paratantellon to Leo of the zodiac.

*Boundaries and Contents.*—North by Ursa Major, east by Coma Berenices, south by Leo, and west by Lynx. This constellation contains 53 stars, *viz.* one of the 3d magnitude, six of the fourth, eleven of the 5th, &c. and the upper part of the animal's head does not set to London. The position of Leo Minor is easily ascertained, for it is composed as it were of three knots of stars, one at the head and fore feet, a second on the body, and a third at the tail; and the central group, determined by a line drawn from Regulus to the Pointers, enables us to fix on the two others to the east and west.

**Leo**, *the Lion* ♌, is the fifth sign in the order of the zodiac, and the second of the summer signs. According to the fixed zodiac and the astronomical year, the Sun enters *Leo* on the 23d of July; but reckoning agreeably to the precession of the equinoxes and the moveable zodiac of the sidereal year, the Sun enters this sign on the 8th of August. The Earth is at this period in Aquarius, and the Sun, as seen from the Earth, appears in Leo. For, in whatever part of the ecliptic we apprehend the Sun to be, the Earth is 180° removed from that point. As the Earth goes round the Sun, the North Pole keeps constantly towards one part of the heavens; it now approaches nearer its orbit than in the preceding sign, and the days and nights are consequently coming nearer to an equality.

*Boundaries and Contents of Leo.*—This sign is bounded on the north by Leo Minor, east by Virgo, south by Sextans, and west by Cancer; it contains 95 stars, *viz.* two of the 1st magnitude, two of the 2d, six of the 3d, thirteen of the 4th, &c. The chief star is Regulus, situated on the Ecliptic, and sometimes called *Cor Leonis*, "the Lion's heart." In the tail of the Lion we find Denebola, also a star of the first magnitude. The declination of Regulus is 12° 56′ 26″ north, and its right ascension 149° 25′ 29″. Regulus rises in the E. N. E. part of the horizon, as does also Denebola, but about 4° more to the N. and 1 hour 30 minutes after Regulus. Regulus rises and culminates, to the inhabitants of London, for the first of every month, agreeably to the following Table: Merid. Alt. 51° 25′ 26.″

| Month. | Rises. | Culm. | Month. | Rises. | Culm. |
|---|---|---|---|---|---|
| | ho. mi. | ho. mi. | | ho. mi. | ho. mi. |
| Jan. | 10 15 A. | 3 10 M. | July | 3 12 M. | 3 19 A. |
| Feb. | 6 0 A. | 1 0 M. | Aug. | 6 0 M. | 1 14 A. |
| Mar. | 4 10 A. | 10 9 A. | Sept. | 4 0 M. | 11 15 M. |
| April | 2 15 A. | 9 16 A. | Oct. | 2 15 M. | 9 27 M. |
| May | 12 20 A. | 7 25 A. | Nov. | 12 22 M. | 7 30 M. |
| June | 10 8 M. | 5 23 A. | Dec. | 10 22 M. | 5 27 M. |

The sign *Leo* is chiefly situated north of the Ecliptic, passing over the northern parts of the torrid zone. And in the heavens the position of Regulus and Denebola may be thus found.

**LEPAS**, the *Acorn*, a genus of shell-fish, belonging to the order of vermes testacea.

**LEPIDIUM, Dittander**, or **Pepperwort**, a genus of plants belonging to the tetradynamia class, and in the natural method ranking under the 39th order, siliquosæ.

**LEPIDIOPTERA**, in Zöology, an order of insects, with four wings, which are covered with imbricated scales.

**LEPROSY**, a foul cutaneous disease, appearing in dry, white, thin, scurfy scabs, either on the whole body, or only some parts of it, and usually attended with a violent itching and other pains. The leprosy is of various kinds, but Jews were particularly subject to that called *Elephantiasis*. Hence the Jewish law excluded lepers from communion with mankind, banishing them into the country or uninhabited places, without excepting even kings. When a leper was cleansed, he came to the city gate, and was there examined by the priests; after this he took two live birds to the temple, and fastened one of them to a wisp of cedar and hissop, tied together with a scarlet ribbon; the second bird was killed by the leper, and the blood of it received into a vessel of water; with this water the priest sprinkled the leper, dipping the wisp and the live bird into it: this done, the live bird was let go; and the leper having undergone this ceremony, was again admitted into society, and to the use of things sacred. *See* Levit. xiii. 46, 47, and xiv. 1, 2, &c.

**L'ERMITE (Oiseau)**, a constellation formed some years ago by M. Monnier, under the southern scale of the Celestial Balance. Dr. Jamieson, on his Celestial Atlas, has transformed *L'Ermite Oiseau* into the sage-looking *Noctua*, a bird, which, considering the frequency it is met with on all Egyptian monuments, it appears strange our astronomers have not long ere this transferred among the celestials.

**LETHARGY**, (a word of Greek derivation,) in Medicine, is a disease consisting of a profound drowsiness or sleepiness, from which the patient can scarcely be awaked; or, if awaked, he remains stupid, without sense or memory, and presently sinks again into his former sleep.

**LETTER of Attorney**, in Law, is a writing by which one person authorizes another to do some lawful act in his stead; as, to give seisure of lands, to receive debts, sue a third person, &c. The nature of this instrument is, to transfer to the person to whom it is given, the whole power of the maker, to enable him to accomplish the act intended to be performed. It is either general or special; and sometimes it is made revocable, which is when a bare authority is only given, and sometimes it is irrevocable, as where debts, &c. are assigned from one person to another. It is generally held, that the power granted to the attorney must be strictly pursued; and that where it is made to three persons, two cannot execute it. In most cases, the power given by a letter of attorney terminates upon the death of the person who gave it. No letter of attorney made by a seaman, &c. in any ship of war, or having letter of warfare, or by their executors, &c. in order to empower any person to receive any share of prizes or bounty-money, shall be valid, unless the same be made revocable, and for the use of such seaman, and be signed and executed before, and attested by, the captain and one other of the signing officers of the ship, or the mayor or chief magistrate of some corporation.

**LETTER of Mart**, a commission granted by the lords of the admiralty, or by the vice-admiral of any distant province, to the commander of a merchant ship, or privateer, to cruise against and make prizes of the enemy's ships and vessels, either at sea, or in their harbours. The ship so commissioned is also called a Letter of Mart or Marque.

**LETTUCE, Wild.** Dr. Collin, at Vienna, first brought the wild lettuce into medical repute; and its character has lately induced the College of Physicians at Edinburgh to insert it in the catalogue of the Materia Medica. More than 24 cases of dropsy are said by Collin to have been successfully treated, by employing an extract prepared from the pressed juice of this plant, which is stated not only to be powerfully diuretic, but, by attenuating the viscid humours, to promote all the secretions, and to remove visceral obstructions. In the more simple cases, proceeding from debility, the extract, in doses of eighteen to thirty grains a day, proved sufficient to accomplish a cure; but when the disease was inveterate, and accompanied with visceral obstructions, the quantity of extract was increased to three drachms; nor did larger doses, though they excited nausea, ever produce any other bad effect; and the patients continued so strong under the use of this remedy, that it was seldom necessary to employ any tonic medicines. Strong-scented wild lettuce ranks, however, among the stupefying poisons; but it is to be hoped, that its disagreeable scent and bitter nauseous taste will operate as a preventive to its being used for food.

**LEUCIPPUS**, an ancient Greek philosopher, who flourished about 420 years before Christ.

**LEUWENHOEK, Anthony**, a celebrated Dutch philosopher, was born at Delft in 1632, and acquired a great reputation throughout all Europe, by his experiments and discoveries in Natural History, by means of the microscope. He particularly excelled in making glasses for microscopes and spectacles; and he was a member of most of the literary societies of Europe, to whom he sent many memoirs. Those in the Phil. Trans. and in the Paris Memoirs, extend through many volumes; the former were extracted, and published at Leyden, in 1722. He died in 1723, at ninety-one years of age.

**LEVEL**, an instrument employed in ascertaining a horizontal line, of which there are various sorts; as,

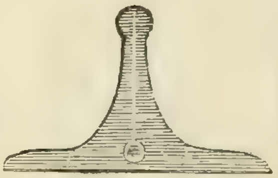
The *Air* Level, shews the exact level by means of a bubble of air enclosed with some fluid in a glass tube of an indeterminate length and thickness, and having its two ends hermetically sealed. When the bubble fixes itself at a mark in the middle of the tube, the case in which it is fixed is then level. When it is not level, the bubble will rise to one end. This glass tube may be set in another of brass, having an aperture in the middle, where the bubble may be observed. The liquor with which the tube is filled is oil of tartar, or aqua secunda; those not being liable to freeze as common water, nor to rarefaction and condensation as spirit of wine is.

The *Plumb* Level, shews the horizontal line by means of another line perpendicular to that described by a plummet at pendulum. This instrument consists of two legs, joined or right angles; of these legs, that which carries the thread and plummet is about a foot and a half long; the thread is hung towards the top of the branch. The middle of the branch where the thread passes is hollow, so that it may hang free every where; but towards the bottom, where there is a little blade of silver, whereon is drawn a line perpendicular to the telescope, the said cavity is covered by two pieces of brass, making a kind of case, lest the wind should agitate the thread; for which reason the silver blade is covered with a glass to the end, to be seen when the thread and plummet play upon the perpendicular. The telescope fastened to the other branch of the instrument, is about two feet long; having a hair placed horizontally across the focus of the object-glass, which determines the point of the level. The telescope must be fitted at right angles to the perpendicular. It has a ball and socket, by which it is fastened to the foot.

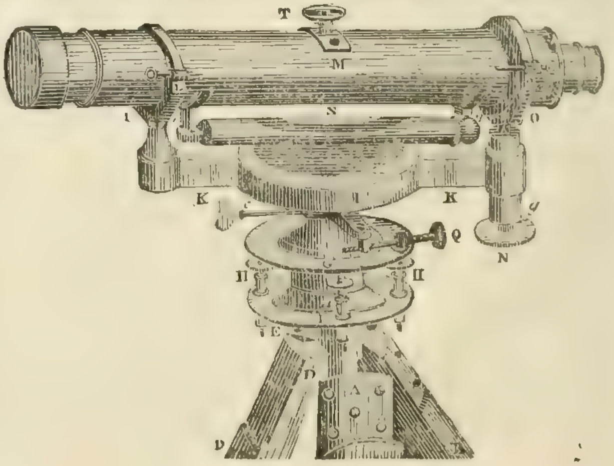
The *Water* Level, shews the horizontal line by means of a surface of water or other fluid; founded on this principle, that water always places itself horizontally. The most simple kind, made of a long wooden trough, equally filled with water, shews its surface on the line of level. This is the ancient *chorobates.*

The water-level is also made with two cups fitted to the two ends of a straight pipe, an inch in diameter, and four feet long. The water communicates from one cup to the other; and this pipe being moveable on its stand by a ball and socket, when the two cups shew equally full of water, their two surfaces mark the line of level. This instrument, instead of cups, may also be made with two short cylinders of glass, three or four inches long, fastened to each extremity of the pipe with wax or mastic. The pipe, filled with coloured water, shews itself through the cylinders, by means of which the line of level is determined; the height of the water, with respect to the centre of the earth, being always the same in both cylinders. This level, though very simple, is yet very commodious for levelling small distances.

Where works of moderate extent are carried on, and where the perfect level of each stratum of materials is not an object of importance, the common bricklayer's level, having a plumb suspended from the top, and received in an opening at the junction of the perpendicular with the horizontal piece, will answer well enough. The principle on which this acts is, that as all weights have a tendency to gravitate towards the centre of the earth, so, the plumb-line being a true perpendicular, any line cutting that at right angles must be a horizontal line at the point of intersection. All this is but an approximation; we may call these perpendiculars, or what we will, they are in fact radii of a sphere.



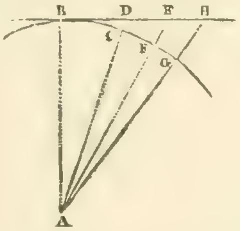
But the most complete level that has ever yet been invented, is the spirit level, of which the following is a representation.



The level *q r* is surmounted by a telescope O M I, and the whole fixed on a stand resembling that of the improved theodolite, the adjustment of the instrument being effected by means of the screws shewn in the figure. The telescope is a chromatic, about 18 inches long, for viewing remote objects. O I are the Y supporters in which it rests. The spirit level shews when the instrument is properly adjusted. The supporters are fixed in the plate K I K. The screws C, Q, G, H, H, E, and F, are severally used for adjusting the instrument, which is supported by three legs A, B, D. The usual height of the instrument is abous 5½ feet; but as an hour's practice will give more information than pages of description, and as the telescope answers the same purpose, we shall refer the reader to that article.

**LEVELLING**, the finding a line parallel to the horizon at one or more stations, to determine the height or depth of one place with respect to another, for laying out grounds even, regulating descents, draining morasses, conducting water, &c.

Two or more places are on a true level when they are equally distant from the centre of the earth. Also one place is higher than another, or out of level with it, when it is farther from the centre of the earth; and a line equally distant from that centre in all its points, is called the line of true level.



Hence, because the earth is round, that line must be a curve, and make a part of the earth's circumference, or at least be parallel to it, or concentrical with it; as the line B C F G, which has all its points equally distant from A, the centre of the earth, considering it as a perfect globe.

But the line of sight B D E, &c. given by the operations of levels, is a tangent, or a right line perpendicular to the semi-diameter of the earth at the point of contact B, rising always higher above the true line of level, the farther the distance is, is called the apparent line of level. Thus, C D is the height of the apparent level, above the true level, at the distance B C or B D; also E F is the excess of height at F, and G H at G, &c. The difference, it is evident, is always equal to the excess of the secant of the arch of distance above the radius of the earth.

The common methods of levelling are sufficient for laying pavements of walks, or for conveying water to small distances, &c.; but in more extensive operations, as in levelling the bottoms of canals, which are to convey water to the distance of many miles, and such like, the difference between the true and the apparent level must be taken into the account.

Now the difference C D between the true and apparent level at any distance B C or B D, may be found thus: by a well-known property of the circle (2 A C + C D); B D : : B D : C D; or because the diameter of the earth is so great with respect to the line C D, at all distances to which an operation of levelling commonly extends, that 2 A C may be safely taken for 2 A C + C D in that proportion without any sensible error, it will be 2 A C : B D : : B D : C D, which therefore is $= \frac{BD^2}{2AC}$, or $\frac{BC^2}{2AC}$ nearly; that is, the difference between the true and apparent level is equal to the square of the distance between the places, divided by the diameter of the earth; and consequently it is always proportional to the square of the distance.

Now the diameter of the earth being nearly 7958 miles, if we first take B C = 1 mile, then the excess $\frac{BC^2}{2AC}$ becomes $\frac{1}{7958}$ of a mile, which is 7·962 inches, or almost eight inches, for the height of the apparent above the true level at the distance of one mile. Hence, proportioning the excesses in altitude according to the squares of the distances, the following table is obtained, shewing the height of the apparent above the true level for every 100 yards of distance on the one hand, and for every mile on the other.

By the following table of reductions, we can now level to almost any distance at one operation, whereas the ancients, being unacquainted with the correction answering to any distance, could only level from one twenty yards to another, when they had occasion to continue the work to a considerable extent.

| Distance, or B. C. | Differ. of Level, or C. D. | Distance, or B C. | Differ. of Level, or C D. | |
|---|---|---|---|---|
| Yards. | Inches. | Miles. | Feet. | Inches. |
| 100 | 0·026 | ¼ | 0 | 0½ |
| 200 | 0·103 | ½ | 0 | 2 |
| 300 | 0·231 | ¾ | 0 | 4½ |
| 400 | 0·411 | 1 | 0 | 8 |
| 500 | 0·643 | 2 | 2 | 8 |
| 600 | 0·925 | 3 | 6 | 0 |
| 700 | 1·260 | 4 | 10 | 7 |
| 800 | 1·645 | 5 | 16 | 7 |
| 900 | 2·081 | 6 | 23 | 11 |
| 1000 | 2·570 | 7 | 32 | 6 |
| 1100 | 3·110 | 8 | 42 | 6 |
| 1200 | 3·701 | 9 | 53 | 9 |
| 1300 | 4·344 | 10 | 66 | 4 |
| 1400 | 5·038 | 11 | 80 | 3 |
| 1500 | 5·784 | 12 | 95 | 7 |
| 1600 | 6·580 | 13 | 112 | 2 |
| 1700 | 7·425 | 14 | 130 | 1 |

This table answers several useful purposes. Thus, 1st, to find the height of the apparent level above the true, at any distance. If the given distance is in the table, the correction of level is found on the same line with it: thus at the distance of 1000 yards, the correction is 2·57, or two inches and a half nearly; and at the distance of 10 miles it is 66 feet 4 inches. But if the exact distance is not found in the table, then multiply the square of the distance in yards by 2·57, and then divide by 1,000,000, or cut off six places on the right for decimals, the rest are inches: or multiply the square of the distance in miles by 66 feet 4 inches, and divide by 100

2dly. To find the extent of the visible horizon, or how far an observer can see from any given height, on a horizontal plane, as at sea, &c. Suppose the eye of the observer, on the top of a ship's mast at sea, is the height of 130 feet above the water, he will then see about 14 miles all around. Or from the top of a cliff by the sea-side, the height of which is 66 feet, a person may see to the distance of near 10 miles on the surface of the sea. Also when the top of a hill, or the light in a light-house, or such like, whose height is 130 feet, first comes into the view of an eye on board a ship, the table shews that the distance of the ship from it is 14 miles, if the eye is at the surface of the water; but if the height of the eye in the ship is 80 feet, then the distance will be increased by near 11 miles, making in all about 25 miles in distance.

3dly. Suppose a spring on one side of a hill, and a house on an opposite hill, with a valley between them, that the spring seen from the house appears by a levelling instrument on a level with the foundation of the house, which suppose is at a mile distance from it; then is the spring eight inches above the true level of a house; and this difference would be barely sufficient for the water to be brought in pipes from the spring to the house, the pipes being laid all the way in the ground.

4thly. If the height or distance exceed the limits of the table, then, first, if the distance be given, divide it by 2, or by 3, or by 4, &c. till the quotient come within the distances in the table; then take out the height answering to the quotient, and multiply it by the square of the divisor, that is, by 4, or 9, or 16, &c. for the height required. Thus, if the top of a hill is just seen at the distance of 40 miles, then 40 divided by 4 gives 10, to which in the table answer 66⅓ feet, which being multiplied by 16, the square of 4, gives 1061⅓ feet for the height of the hill. But when the height is given, divide it by one of these square numbers, 4, 9, 16, 25, &c. till the quotient come within the limits of the table, and multiply the quotient by the square root of the divisor; that is, by 2, or 3, or 4, or 5, &c. for the distance sought: so when the top of the peak of Teneriffe, said to be about 3 miles, or 15,840 feet high, just comes into view at sea, divide 15,840 by 225, or the square of 15, and the quotient is 70 nearly; to which in the table answers by proportion nearly $10\frac{2}{7}$ miles; then multiplying $10\frac{2}{7}$ by 15, gives 154 miles and $\frac{2}{7}$ for the distance of the hill.

What has been stated above, has been said without any regard to the effect of refraction in elevating the apparent places of objects. But as the operation of refraction incurvating the rays of light proceeding from objects near the horizon is considerable, it can by no means be neglected, when the difference between the true and apparent level is estimated at considerable distances. It is now ascertained, that for horizontal refractions the radius of curvature of the curve of refraction is about seven times the radius of the earth; in consequence of which, the distance at which an object can be seen by refraction, is to the distance at which it could be seen without refraction, nearly as 14 to 13; the refraction augmenting the distance at which an object can be seen by about a thirteenth of itself. By reason of this refraction, too, it happens, that it is necessary to diminish by $\frac{1}{7}$ of itself the height of the apparent above the true level, as given in the preceding table of reductions. Thus, at 1000 yards, the true difference of level, when the allowance is made for the effect of refraction, will be $2{\cdot}570 - {\cdot}367 = 2{\cdot}203$ inches. At two miles it would be $32 - 4\frac{4}{7} = 27\frac{3}{7}$ inches; and so on.

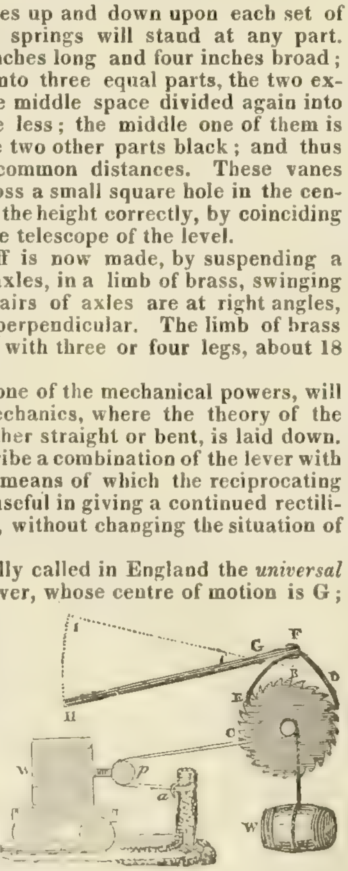
**Levelling**, is either simple or compound; the former is when the level points are determined from one station, whether the level be fixed at one of the points or between them; and the latter, or compound levelling, is nothing more than a repetition of several such simple operations.

**Levelling** *Staves*, instruments used in levelling, serving to carry the marks to be observed, and at the same time to measure the height of those marks from the ground. They usually consist of two mahogany staves, ten feet long, in two parts that slide upon one another to about $5\frac{1}{10}$ feet, for the greater convenience of carriage. They are divided into 1000 equal parts, and numbered at every tenth division, by 10, 20, 30, &c. to 1000; and on one side the feet and inches are also sometimes marked. A vane slides up and down upon each set of these staves, which by brass springs will stand at any part. These vanes are about ten inches long and four inches broad; the breadth is first divided into three equal parts, the two extremes are painted white, the middle space divided again into three equal parts, which are less; the middle one of them is also painted white, and the two other parts black; and thus they are suited to all the common distances. These vanes have each a brass wire across a small square hole in the centre, which serve to point out the height correctly, by coinciding with the horizontal wire of the telescope of the level.

An excellent levelling staff is now made, by suspending a pole on a pair of pivots or axles, in a limb of brass, swinging itself on axles; these two pairs of axles are at right angles, and the pole stands always perpendicular. The limb of brass is fixed in the top of a stool, with three or four legs, about 18 inches from the ground.

**LEVER, The**, treated as one of the mechanical powers, will fall under our notice in Mechanics, where the theory of the various kinds of levers, whether straight or bent, is laid down. Our present object is to describe a combination of the lever with the axis in peritrochio, by means of which the reciprocating motion of the lever is made useful in giving a continued rectilinear motion to a heavy body, without changing the situation of the fulcrum of the lever.

This contrivance is generally called in England the *universal lever*. F G H is a straight lever, whose centre of motion is G; on its extremity F, hang two bars F D, F E, the former of which has a hook to catch into the teeth of the wheel A C D, and the latter has its end slightly bent, so as to slide over the outer parts of those teeth. The axle A has a cord wound about it, to the lower end of which is attached the weight W. Now suppose the end H of the lever raised from H by I, while the other end descends from F to B; the bar F E will then push the point E of the wheel from E to C, while the hook D slides over an equal space on the other side of the wheel. After this, on the end H of the lever being brought down again by I to H, the end F ascends through B F, and the hook D raises up the left hand side of the wheel through a space equal to E C. Thus the reciprocating motion of the lever is made to communicate a continued rotatory motion to the wheel, and consequently to raise the weight W suspended from its axle by the cord. Here the advantage gained, neglecting friction and the stiffness of the cord, will be in the ratio compounded of the ratio of H G to G F, and the ratio of the radius of the wheel to that of the axle. Thus if H G were ten times G F, and the radius of the wheel ten times that of the axle, the power would then be to the weight raised nearly as 1 to 100.



This machine has been advantageously applied in drawing heavy loads along a plane nearly horizontal: in that case, the cord has been carried from A in nearly an horizontal direction, passed round a pulley *p*, attached to the load *w* or its carriage, and its end fixed to a post as at *a*, or perhaps to the frame of the wheel and axle. The pulley, it is obvious, almost doubles the advantage of the power; and since the force to be overcome, when once the system is put in motion, is not equivalent to the whole load *w*, but merely to the friction, and the rigidity of the rope, a very great weight may be moved in this manner by a comparatively small power. If the lever have another arm to the left of G (as it appears in the figure) equal to G H, a man may then work at each end, either by pressing upon it or by pulling downwards with a cord; and thus the labourers will alternately relieve each other. Sometimes a heart-wheel has been combined with this universal lever: but it is not, we think, a combination to be recommended in practice.

If the centre of motion G were vertically above the centre of the wheel, and if another bar and hook similar and equal in length to F D hung from the point *f*, *f* G being equal to G F; these two hooks would then catch alternately into the teeth on the rising side of the wheel, and thus produce the continued rotatory motion; but this construction has a practical disadvantage; for when both bars work on the same side of the wheel, they will be in great danger of catching together, and impeding each other's motions. Universal levers have long been introduced into saw mills, for the purpose of drawing along the logs to be sawn. *See* Saw Mill, also Pipe Borer.

**LEVIGATION**, in Pharmacy and Chemistry, the reducing hard and ponderous bodies to an impalpable powder, by grinding them on a porphyry or in a mill.

**LEVITY**, in Philosophy, the opposite to gravity, or that supposed quality of certain bodies which gives them a power of ascent; being thus opposed to gravity, by which they have always a tendency to descend. The ancients supposed several different bodies to be possessed of levity, but the error has long since been detected, and the principle itself excluded from every system of philosophy.

**LEX, Law.** *See* Law. The Roman laws were of two kinds: 1st. Such as were made by their kings. 2d. The laws of the twelve tables, brought by the Decemviri from Athens, &c. And 3d. Such as were proposed by the superior magistrates in the times of the republic.

**LEXICON**, the same with Dictionary. The word is chiefly used in speaking of Greek dictionaries.

**LEYDEN Phial**, in Electricity, is a glass phial or jar, coated both within and without with tin-foil, or some other conducting substance, which may be charged, and employed in a variety of useful and entertaining experiments. Or even flat glass, or any other shape, so coated and used, has also received the same denomination. Also, a vacuum produced in such a jar, &c. has been named the Leyden vacuum.

**LIBELLUS FAMOSUS.** A contumely or reproach, published to the defamation of the government, of a magistrate, or of a private person. It is also defined a malicious defamation, expressed in printing or writing, or by signs, pictures, &c. tending either to blacken the memory of one who is dead, or the reputation of one who is alive, and thereby exposing him to public hatred, contempt, and ridicule. Libels, says Blackstone, taken in their largest and most extensive sense, signify any writings, pictures, or the like, of an immoral or illegal tendency. This species of defamation is usually termed written scandal and thereby receives an aggravation, in that it is presumed to have been entered upon with coolness and deliberation; and to continue longer, and propagate wider and further, than any other scandal.

**LIBRA**, *the Balance* ♎. This is the seventh sign in the order of the Ecliptic, and the first of the southern and autumnal signs. The sun enters it on the 23d of September, reckoning according to the fixed and intellectual zodiac; but, agreeably to the moveable and visible zodiac, and the recession of the signs, it is the 27th of October when the place of the sun corresponds with the commencement of Libra. By the former way of reckoning, we are accustomed to say, that when the Sun comes to Libra, he has no declination, that the days and nights are then equal all over the earth, except at the poles; and that is the beginning of day at the South Pole, and the end of day at the North Pole.—*Boundaries and Contents.*—Libra is bounded on the north by Mons Mænalus and Serpens, east by Scorpio, south by Centaurus and Lupus, and west by Virgo. It contains 51 stars, two of which are of the 2d magnitude, one of the 3d, eight of the 4th, &c.

*α* Zuben el Genubi, situated on the Ecliptic, and in the Southern Scale, rises on the E. S. E. point of the compass, at London; its right ascension is 220° 11′ 18″; its declin. 15° 14′ 28″ S. *α* is a double star, and the mean right ascension of the two stars may be taken at 14 ho. 40 mi. and 57″;—their southern declination at 15° 15′ 47″. The times of their rising and culminating are shewn in the following Table, for the first day of each month in the year; Merid. Alt. 23° 14′ 32″.

| MONTH. | RISES. ho mi. | CULM. ho. mi. | MONTH. | RISES. ho. mi. | CULM. ho. mi. |
|---|---|---|---|---|---|
| Jan. | 3 15 M. | 6 26 M. | July | 3 30 A. | 6 38 A. |
| Feb. | 1 10 M. | 4 14 M. | Aug. | 1 30 A. | 4 31 A. |
| Mar. | 11 15 A. | 2 25 M. | Sept. | 11 25 M. | 2 25 A. |
| April | 9 30 A. | 0 32 M. | Oct. | 9 30 M. | 0 47 A. |
| May | 7 40 A. | 10 41 A. | Nov. | 7 35 M. | 10 47 M. |
| June | 5 50 A. | 8 39 A. | Dec. | 5 25 M. | 8 43 M. |

**LIBRA** also denotes the ancient Roman pound, which was equal to about 5040 of our Troy grains. It was likewise the name of one of their gold coins, equal in value to 20 denarii. See Phil. Trans. vol. lxi. p. 462.

**LIBRARIAN**, one who has the care of a library.

**LIBRARY**, an edifice, or an apartment in a building, fitted up for the reception of books. The term is also frequently applied to the books themselves, with scarcely any reference to the building. Some authors refer the origin of libraries to the Hebrews, who were always careful to preserve their sacred books, and such memorials as regarded their ancestors. This method was imitated by the Egyptians, who, next to the Israelites, were the first to erect libraries. Many famous libraries have existed in different periods of time, among which, that of Alexandria was the most remarkable. When destroyed by the Saracens, it consisted of 700,000 volumes, and in it perished the learning of the ancient world. In former times every large church had its library, but at present the most distinguished in this country are the *Bodleian* at Oxford, and the *Cottonian* in the British Museum.

**LIBRATION OF THE EARTH**, is a term applied by some astronomers to that motion, whereby the earth is so retained within its orbit, as that its axis continues constantly parallel to the axis of the world. This Copernicus calls the motion of libration, and may be illustrated thus: Suppose a globe, with its axis parallel to that of the earth, painted on the flag of a mast, moveable on its axis, and constantly driven by an east wind, while it sails round an island; it is evident the painted globe will be so librated as that its axis will be parallel to that of the world, in every situation of the ship.

**LIBRATION** *of the Moon*, in Astronomy, is more particularly applied to denote an apparent irregular libratory motion of that body about her own axis, whereby we see a little more than one-half of the lunar disc; or rather, it is in consequence of our seeing more than one-half of it, that the moon appears to have such a motion; for although the term libration, from the Latin *libratio*, to *balance*, agrees perfectly well with the appearances observed, still it must not be understood in a positive sense, the appearance itself arising from a totally different cause from that which the word seems to indicate. In order to illustrate this, let us conceive a visual ray drawn from the centre of the earth to the centre of the moon: the plane drawn through the latter centre perpendicularly to this ray, will cut the lunar globe according to the circumference of a circle which is, with respect to us, the apparent disc. If the moon had no real rotatory motion, its motion of revolution solely would discover to us all the points of its surface in succession: the visual ray would therefore meet that surface successively in different points, which to us would appear to pass the one after the other, to the apparent centre of the lunar disc. The real rotatory motion counteracts the effects of this apparent rotation, and brings back constantly towards us the same face of the lunar globe.

Suppose, now, that the rotation of the moon is sensibly uniform; that is to say, that it does not partake of any periodical inequalities, (this supposition is at least the most natural which we can make, and it is conformable to observations;) then one of the causes which produce the libration will become evident; for the motion of revolution partaking of the periodical inequalities, is sometimes slower, sometimes more rapid: the apparent rotation which it occasions cannot, therefore, always exactly counterbalance the actual rotation, which remains constantly the same; and these two effects will surpass each other by turns. The points of the lunar globe ought, therefore, to appear turning sometimes in one direction, sometimes in another, about its centre; and the resulting appearance is the same as if the moon had a little vibratory balancing from one side to the other of the radius vector drawn from its centre to the earth. It is this which is named the libration in longitude.

Several accessory but sensible causes modify this first result. The spots of the moon do not always retain the same elevation above the plane of its orbit; indeed some of them, by the effect of the rotation, pass from one side of this plane to the opposite side. These circumstances indicate an axis of rotation which is not exactly perpendicular to the plane of the lunar orbit; but according as this axis presents to us its greater or its smaller obliquity, it must discover to us successively the two poles of rotation of the lunar spheroid: hence it is we perceive, at certain times, some of the points situated towards these poles, and lose the sight of them afterwards, when they arrive nearer the apparent edge: this is called the libration in latitude. It is but inconsiderable, and therefore indicates that the equator of the moon differs very little in position from the plane of its orbit.

Finally, a third illusion arises from the observer being placed at the surface of the earth, and not at its centre. Towards this centre it is that the moon always turns the same face; and the visual ray drawn thence to the centre of the moon would always meet its surface at the same point, abstracting from the preceding inequalities. It is not the same with respect to the visual ray drawn from the surface of the earth; for this ray makes a sensible angle with the former, by reason of the proximity of the moon; this angle is, at the horizon, equal to the horizontal parallax: in consequence of this difference the apparent contour of the lunar spheroid is not the same for the centre of the earth, and to an observer placed at its surface. This, when the moon rises, causes some points to be discovered towards its upper edge, which could not have been perceived from the centre of the earth: as the moon rises above the horizon, these points continue to approach the upper edge of the disc, and at length disappear, while others become visible to its lower edge: the same effect is continued during all the time that the moon is visible; and, as the part of its disc which appears highest at its rising is found lowest at its setting, these are the two instants when the difference is most perceptible. Thus the lunar globe, in its diurnal motion, appears to oscillate about the radius vector drawn from its centre to the centre of the earth. This phenomenon is designated by the name of diurnal libration.

**LICENSE**, in Law, is a power or authority given to another to do some lawful act. A license is personal, and cannot be transferred to another without the sanction of the original authority. Licenses are of various kinds, and encircle almost every department of law, of commerce, and of other actions in their wide embrace.

**LICENTIATE**, among us is generally understood of a physician, who has a license to practice granted him by the college of physicians, or by the bishop of the diocese. A person practising physic without such license, in case his patient dies under his hands, is guilty of felony in the eye of the law.

**LICHEN**, in Botany, a name borrowed by the Romans from the Greeks for the disease called a tetter or ringworm, and applied by both to a plant of a mossy nature, growing on stones, which was thought to be a cure for such complaints.

**LIE**, in Morals, denotes a criminal breach of veracity. Archdeacon Paley, in treating of this subject, observes, that there are falsehoods which are not lies; that is, which are not criminal: and there are lies, which are not literally and directly false.

**LIEGE**, Leguis, in Law, properly signifies a vassal, who holds a kind of fee, that binds him in a closer obligation to his lord than other people.

**LIENTERY**, a flux of the belly, in which the aliments are discharged as they are swallowed, or very little altered in colour or substance.

**LIEUTENANT**, an officer who supplies the place, and discharges the office, of a superior in his absence. Of these, some are civil, as the lords-lieutenants of kingdoms, and the lords-lieutenants of counties; and others are military, as the lieutenant-general, lieutenant-general of the artillery, lieutenant-colonel, lieutenant of artillery of the Tower, lieutenants of horse, foot, ships of war, &c.

**LIFE**, a term that implies the existence and duration of soul and body, or the period of their union.

**LIFE** Annuities, are such periodical payments as depend on the continuance of some particular life or lives; and they may be distinguished into lives, to commence immediately; and annuities, to commence at some future period, called reversionary annuities.

The value or present worth of an annuity for any proposed life or lives, it is evident depends on two circumstances; the interest of money, and the chance or expectation of the continuance of life. Upon the former only depends the value or present worth of an annuity certain, or that which is not subject to the continuance of a life or other contingency; but the expectation of life being a thing not certain, but only possessing a certain *chance*, it is evident, that the value of the certain annuity, as stated above, must be diminished in proportion as the expectancy is below certainty; thus, if the present value of an annuity certain be any sum, as suppose £100, and the value and expectancy of the life be one-half, then the value of the life annuity will be only half of the former, or £50; and if the value of the life be only one-third, the value of the life annuity will be but one-third of £100, that is, £33. 6*s.* 8*d.* and so on.

The measure of the value or expectancy of life, depends on the proportion of the number of persons that die, out of a given number, in the time proposed; thus, if fifty persons die out of one hundred, in any proposed time, then half the number only remaining alive, any one person has an equal chance to live or die in that time, or the value of his life for that time is one-half: but if two-thirds of the number die in the time proposed, or only one-third remain alive, then the value of any life is one-third; and if three-quarters of the number die, or only one-quarter remain alive, then the value of any life is but one-quarter; and so on. In these proportions then must the value of the annuity certain be diminished, to give the value of the life annuity. It is plain, therefore, that in this business it is necessary to know the value of life at all the different ages, from some table of observations on the mortality of mankind, which may shew the proportion of the persons living, out of a given number, at the end of any proposed time; or from some certain hypothesis, or assumed principle. It may not, therefore, be improper to insert here a comparative view of two of the principal tables that have been given of this kind, as the following, where the first column shews the age, and the other columns the number of persons living at that age, out of 1000 born, or of the age 0, in the first line of each column.

The uses of these tables may be exemplified in the following problems:—

*Problem* 1.—*To find the Probability or Proportion of Chance, that a Person at a given Age continues in being a proposed number of Years.*—Thus, suppose the age to be 40, and the number of years proposed 15; then to calculate by the table of the probabilities for London, in table 1, against 40 years stands 214; and against 55 years, the age to which the person must arrive, stands 120; which shews, that of 214 persons who attain to the age of 40, only 120 of them reach the age of 55, and consequently 94 die between the ages of 40 and 55. It is evident, therefore, that the odds for attaining the proposed age of 55, are as 120 to 94, or as 9 to 7 nearly.

*Problem* 2.—*To find the Value of an Annuity for a proposed Life.*—This problem is resolved from table 2, by looking against the given age, and under the proposed rate of interest; then the corresponding quantity shews the number of years' purchase required. For example, if the given age be 36, the rate of interest 4 per cent. and the proposed annuity £250. Then in the table it appears, that the value is 12·1 years purchase, or 12·1 times £250, that is, £3025·1. After the same manner, the answer will be found in any other case falling within the limits of the table. But as there may sometimes be occasion to know the values of lives computed at higher rates of interest than those in the table, the two following practical rules are subjoined, by which the problem is resolved independent of tables.

*Rule* 1. When the given age is not less than 45 years, nor greater than 85, subtract it from 92; then multiply the remainder by the perpetuity, and divide the product by the said remainder added to 2½ times the perpetuity; so shall the quotient be the number of years' purchase required. Where note, that by the perpetuity is meant the number of years' purchase of the fee-simple; found by dividing 100 by the rate per cent. at which interest is reckoned.

*Example.* Let the given age be 50 years, and the rate of interest 10 per cent. Then subtracting 50 from 92, there remains 42; which multiplied by 10 the perpetuity, gives 420; and this divided by 67, the remainder increased by 2½ times 10 the perpetuity, gives 6·3 nearly, for the number of years' purchase. Therefore, supposing the annuity to be £100, its value in present money will be £630.

*Rule* 2. When the age is between 10 and 45 years, take eight-tenths of what it wants of 45, which divide by the rate per cent. increased by 1·2; then if the quotient be added to the value of a life of 45 years, found by the preceding rule, there will be obtained the number of years' purchase in this case. For example, let the proposed age be 20 years, and the rate of interest 5 per cent. Here taking 20 from 45, there remains 25; eight-tenths of which is 20; which divided by 6·2, quotes 3·2; and this added to 9·8, the value of a life of 45, found by the former rule, gives 13 for the number of years' purchase that a life of 20 ought to be valued at. And the conclusions derived by these rules are said, by Simpson, to be so near the true values, computed from real observations, as seldom to differ from them by more than one-tenth or two-tenths of one year's purchase.

The observations here alluded to, are those which are founded on the London bills of mortality. And a similar method of solution, accommodated to the Breslaw observations, will be as follows: *viz.* Multiply the difference between the given age and 85 years by the perpetuity, and divide the product by eight-tenths of the said difference, increased by double the perpetuity for the answer; which, from 8 to 80 years of age, will commonly come within less than one-eighth of a year's purchase of the truth.

*Problem* 3.—*To find the Value of an Annuity for the longest of two Lives; that is, for as long as either of them continue in being.*—In table 3, find the age of the youngest life, or the nearest to it, in col. 1, and the age of the elder in col. 2; then against this last is the answer in the proper column of interest.

*Example.* So if the two ages be 15 and 40, then the value of the annuity upon the longest of two such lives,

is 21·1 years' purchase, at 3 per cent.
or 17·9 .............. at 4 ........
or 15·7 .............. at 5 ........

*Note.* In the last two problems, if the younger age, or the rate of interest, be not exactly found in the tables, the nearest to them may be taken; and then, by proportion, the value for the true numbers will be nearly found.

**TABLE I.** *Exhibiting the Decrease of Life, at all Ages, from 1 Year to 90, as deduced from the Bills of Mortality in London and Northampton.*

| Ages. | London. | Northampton. | Ages. | London. | Northampton. | Ages. | London. | Northampton. | Ages. | London. | Northampton. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1000 | 1000 | 23 | 310 | 426 | 46 | 174 | 275 | 69 | 56 | 113 |
| 1 | 680 | 738 | 24 | 305 | 419 | 47 | 167 | 268 | 70 | 52 | 106 |
| 2 | 548 | 628 | 25 | 299 | 412 | 48 | 159 | 261 | 71 | 47 | 99 |
| 3 | 492 | 585 | 26 | 294 | 405 | 49 | 153 | 254 | 72 | 43 | 92 |
| 4 | 452 | 562 | 27 | 288 | 398 | 50 | 147 | 247 | 73 | 39 | 85 |
| 5 | 426 | 544 | 28 | 283 | 391 | 51 | 141 | 239 | 74 | 35 | 78 |
| 6 | 410 | 530 | 29 | 278 | 384 | 52 | 135 | 232 | 75 | 32 | 71 |
| 7 | 397 | 518 | 30 | 272 | 378 | 53 | 130 | 225 | 76 | 28 | 64 |
| 8 | 388 | 510 | 31 | 266 | 372 | 54 | 125 | 218 | 77 | 25 | 58 |
| 9 | 380 | 504 | 32 | 260 | 366 | 55 | 120 | 211 | 78 | 22 | 52 |
| 10 | 373 | 498 | 33 | 254 | 360 | 56 | 116 | 204 | 79 | 19 | 46 |
| 11 | 367 | 493 | 34 | 248 | 354 | 57 | 111 | 197 | 80 | 17 | 40 |
| 12 | 361 | 488 | 35 | 242 | 348 | 58 | 106 | 190 | 81 | 14 | 34 |
| 13 | 356 | 484 | 36 | 236 | 342 | 59 | 101 | 183 | 82 | 12 | 28 |
| 14 | 351 | 480 | 37 | 230 | 336 | 60 | 96 | 176 | 83 | 10 | 23 |
| 15 | 347 | 475 | 38 | 224 | 330 | 61 | 92 | 169 | 84 | 8 | 19 |
| 16 | 343 | 470 | 39 | 218 | 324 | 62 | 87 | 162 | 85 | 7 | 16 |
| 17 | 338 | 465 | 40 | 214 | 317 | 63 | 83 | 155 | 86 | 6 | 13 |
| 18 | 334 | 459 | 41 | 207 | 310 | 64 | 78 | 148 | 87 | 5 | 11 |
| 19 | 329 | 453 | 42 | 201 | 303 | 65 | 74 | 141 | 88 | 4 | 8 |
| 20 | 325 | 447 | 43 | 194 | 296 | 66 | 70 | 134 | 89 | 3 | 6 |
| 21 | 321 | 440 | 44 | 187 | 289 | 67 | 65 | 127 | 90 | 2 | 4 |
| 22 | 316 | 433 | 45 | 180 | 282 | 68 | 61 | 120 | .. | .. | .. |

**TABLE II.** *Shewing the Value of an Annuity on One Life, or Number of Years' Annuity in the Value, supposing Money to bear Interest at the several Rates of 3, 4, and 5 per Cent.*

| Age. | Years' value at 3 per Cent. | Years' value at 4 per Cent. | Years' value at 5 per Cent. | Age. | Years' value at 3 per Cent. | Years' value at 4 per Cent. | Years' value at 5 per Cent. |
|---|---|---|---|---|---|---|---|
| 6 | 18·8 | 16·2 | 14·1 | 41 | 13·0 | 11·4 | 10·2 |
| 7 | 18·9 | 16·3 | 14·2 | 42 | 12·8 | 11·2 | 10·1 |
| 8 | 19·0 | 16·4 | 14·3 | 43 | 12·6 | 11·1 | 10·0 |
| 9 | 19·0 | 16·4 | 14·3 | 44 | 12·5 | 11·0 | 9·9 |
| 10 | 19·0 | 16·4 | 14·3 | 45 | 12·3 | 10·8 | 9·8 |
| 11 | 19·0 | 16·4 | 14·3 | 46 | 12·1 | 10·7 | 9·7 |
| 12 | 18·9 | 16·3 | 14·2 | 47 | 11·9 | 10·5 | 9·5 |
| 13 | 18·7 | 16·2 | 14·1 | 48 | 11·8 | 10·4 | 9·4 |
| 14 | 18·5 | 16·0 | 14·0 | 49 | 11·6 | 10·2 | 9·3 |
| 15 | 18 3 | 15·8 | 13·9 | 50 | 11·4 | 10·1 | 9·2 |
| 16 | 18·1 | 15·6 | 13·7 | 51 | 11·2 | 9·9 | 9·0 |
| 17 | 17·9 | 15·4 | 13·5 | 52 | 11·0 | 9·8 | 8·9 |
| 18 | 17·6 | 15·2 | 13·4 | 53 | 10·7 | 9·6 | 8·8 |
| 19 | 17·4 | 15·0 | 13·2 | 54 | 10·5 | 9·4 | 8.6 |
| 20 | 17·2 | 14·8 | 13·0 | 55 | 10·3 | 9·3 | 8·5 |
| 21 | 17·0 | 14·7 | 12·9 | 56 | 10·1 | 9·1 | 8·4 |
| 22 | 16·8 | 14·5 | 12·7 | 57 | 9·9 | 8·9 | 8·2 |
| 23 | 16·5 | 14·3 | 12·6 | 58 | 9·6 | 8·7 | 8·1 |
| 24 | 16·3 | 14·1 | 12·4 | 59 | 9·4 | 8·6 | 8·0 |
| 25 | 16·1 | 14·0 | 12·3 | 60 | 9·2 | 8·4 | 7·9 |
| 26 | 15·9 | 13·8 | 12·1 | 61 | 8·9 | 8·2 | 7·7 |
| 27 | 15·6 | 13·6 | 12·0 | 62 | 8·7 | 8·1 | 7·6 |
| 28 | 15·4 | 13·4 | 11·8 | 63 | 8·5 | 7·9 | 7·4 |
| 29 | 15·2 | 13·2 | 11·7 | 64 | 8·3 | 7·7 | 7·3 |
| 30 | 15·0 | 13·1 | 11·6 | 65 | 8·0 | 7·5 | 7·1 |
| 31 | 14·8 | 12·9 | 11·4 | 66 | 7·8 | 7·3 | 6·9 |
| 32 | 14·6 | 12·7 | 11·3 | 67 | 7·6 | 7·1 | 6·7 |
| 33 | 14·4 | 12·6 | 11·2 | 68 | 7·4 | 6·9 | 6·6 |
| 34 | 14·2 | 12·4 | 11·0 | 69 | 7·1 | 6·7 | 6·4 |
| 35 | 14·1 | 12·3 | 10·9 | 70 | 6·9 | 6·5 | 6·2 |
| 36 | 13·9 | 12·1 | 10·8 | 71 | 6·7 | 6·3 | 6·0 |
| 37 | 13·7 | 11·9 | 10·6 | 72 | 6·5 | 6·1 | 5·8 |
| 38 | 13·5 | 11·8 | 10·5 | 73 | 6·2 | 5·9 | 5·6 |
| 39 | 13·3 | 11·6 | 10·4 | 74 | 5·9 | 5·6 | 5·4 |
| 40 | 13·2 | 11·5 | 10·3 | 75 | 5·6 | 5·4 | 5·2 |

TABLE III. *For the Value of an Annuity upon the Longer of Two given Lives.*

| Age of Younger. | Age of Elder. | Value at 3 per Cent. | Value at 4 per Cent. | Value at 5 per Cent. |
|---|---|---|---|---|
| 10 | 10 | 23·4 | 19·9 | 17·1 |
| | 15 | 22·9 | 19·5 | 16·8 |
| | 20 | 22·5 | 19·1 | 16·6 |
| | 25 | 22·2 | 18·8 | 16·4 |
| | 30 | 21·9 | 18·6 | 16·2 |
| | 35 | 21·6 | 18·4 | 16·1 |
| | 40 | 21·4 | 18·3 | 16·0 |
| | 45 | 21·2 | 18·2 | 15 9 |
| | 50 | 20·9 | 18·0 | 15·8 |
| | 55 | 20·7 | 17·8 | 15·7 |
| | 60 | 20·4 | 17·6 | 15·5 |
| | 65 | 20·2 | 17·4 | 15·2 |
| | 70 | 19 9 | 17·2 | 14·8 |
| | 75 | 19·5 | 16·8 | 14·3 |
| 15 | 15 | 22·8 | 19·3 | 16·7 |
| | 20 | 22·3 | 18·9 | 16·4 |
| | 25 | 21·9 | 18·6 | 16·2 |
| | 30 | 21·6 | 18·3 | 16·0 |
| | 35 | 21·3 | 18·1 | 15·9 |
| | 40 | 21.1 | 17·9 | 15·7 |
| | 45 | 20 9 | 17·8 | 15·6 |
| | 50 | 20·7 | 17·6 | 15·4 |
| | 55 | 20·4 | 17·4 | 15·3 |
| | 60 | 20·1 | 17·2 | 15·2 |
| | 65 | 19·8 | 16·9 | 15·0 |
| | 70 | 19·4 | 16·6 | 14·7 |
| | 75 | 18·9 | 16·3 | 14·4 |
| 20 | 20 | 21·6 | 18·3 | 15·8 |
| | 25 | 21·1 | 17·9 | 15·5 |
| | 30 | 20·7 | 17·6 | 15·3 |
| | 35 | 20·4 | 17·4 | 15·1 |
| | 40 | 20·1 | 17·2 | 15·0 |
| | 45 | 19·9 | 17·0 | 14·9 |
| | 50 | 19·6 | 16·8 | 14·7 |
| | 55 | 10·4 | 16·6 | 14·5 |
| | 60 | 19·1 | 16·3 | 14·3 |
| | 65 | 18·7 | 16·0 | 14·1 |
| | 70 | 18·2 | 15·7 | 13·8 |
| | 75 | 17·7 | 15·3 | 13·5 |
| 25 | 25 | 20·3 | 17·4 | 15·1 |
| | 30 | 19·8 | 17·0 | 14·9 |
| | 35 | 19·4 | 16·7 | 14·7 |
| | 40 | 19·2 | 16·5 | 14·5 |
| | 45 | 18·9 | 16·3 | 14·3 |
| | 50 | 18·7 | 16·1 | 14·2 |
| | 55 | 18·4 | 15·9 | 14·0 |
| | 60 | 18·0 | 15·6 | 13·8 |
| | 65 | 17·6 | 15·3 | 13·6 |
| | 70 | 17·2 | 15·0 | 13·3 |
| | 75 | 16·7 | 14·6 | 12·9 |
| 30 | 30 | 19·3 | 16·6 | 14·5 |
| | 35 | 18·8 | 16·2 | 14·2 |
| | 40 | 18·4 | 15·9 | 14·0 |
| | 45 | 18·1 | 15·6 | 13·8 |
| | 50 | 17·8 | 15·4 | 13·6 |
| | 55 | 17·4 | 15·1 | 13·4 |
| | 60 | 17·0 | 14·8 | 13·2 |
| | 65 | 16·6 | 14·5 | 12·9 |
| | 70 | 16·1 | 14·1 | 12·6 |
| | 75 | 15·6 | 13·7 | 12·2 |
| 35 | 35 | 18·3 | 15·8 | 13·8 |
| | 40 | 17·8 | 15·4 | 13·5 |
| | 45 | 17·4 | 15·1 | 13·3 |
| | 50 | 17·1 | 14·8 | 13·1 |
| | 55 | 16·7 | 14·5 | 12·9 |
| | 60 | 16·3 | 14·2 | 12·7 |
| | 65 | 15·8 | 13·8 | 12·4 |
| | 70 | 15·3 | 13·4 | 12·0 |
| | 75 | 14·8 | 13·0 | 11·6 |
| 40 | 40 | 17·3 | 15·0 | 13·3 |
| | 45 | 16·8 | 14·6 | 13·0 |
| | 50 | 16·3 | 14·2 | 12·7 |
| | 55 | 15·9 | 13·9 | 12·4 |
| | 60 | 15·4 | 13·5 | 12·1 |
| | 65 | 14·9 | 13·1 | 11·8 |
| | 70 | 14·5 | 12·7 | 11·4 |
| | 75 | 14·0 | 12·3 | 11·0 |
| 45 | 45 | 16·2 | 14·2 | 12·8 |
| | 50 | 15·7 | 13·8 | 12·5 |
| | 55 | 15·2 | 13·4 | 12·1 |
| | 60 | 14·7 | 12·9 | 11·7 |
| | 65 | 14·1 | 12·5 | 11·4 |
| | 70 | 13·6 | 12·0 | 11·0 |
| | 75 | 13·1 | 11·6 | 10·6 |
| 50 | 50 | 15·0 | 13·3 | 12·1 |
| | 55 | 14·5 | 12·9 | 11·7 |
| | 60 | 13·9 | 12·4 | 11·3 |
| | 65 | 13·3 | 12·0 | 10·9 |
| | 70 | 12·8 | 11·5 | 10·5 |
| | 75 | 12·3 | 11·0 | 10·1 |
| 55 | 55 | 13·6 | 12·4 | 11·3 |
| | 60 | 13·0 | 11·9 | 10·9 |
| | 65 | 12·4 | 11·3 | 10·5 |
| | 70 | 11·8 | 10·8 | 10 0 |
| | 75 | 11·3 | 10·3 | 9·5 |
| 60 | 60 | 12·2 | 11·2 | 10·5 |
| | 65 | 11·5 | 10·6 | 10·0 |
| | 70 | 10·9 | 10·1 | 9 5 |
| | 75 | 10·3 | 9·5 | 19·0 |
| 65 | 65 | 10·7 | 10·0 | 9·4 |
| | 70 | 10·0 | 9·4 | 8·9 |
| | 75 | 9·3 | 8·7 | 8·3 |
| 70 | 70 | 9·2 | 8·6 | 8·2 |
| | 75 | 8·4 | 7·9 | 7·6 |
| 75 | 75 | 7·6 | 7·2 | 6·9 |

**LIFE PRESERVER, SCHEFFER'S.**—To the specific gravity of the human body very little attention has been directed; and of the experiments, very small in number, which have been performed to ascertain its weight compared with that of an equal volume of water, very little notice, for practical purposes, has been taken. The inquiries conducted by Mr Robertson, Secretary to the Royal Society, about the year 1760, are now almost forgotten;* and but few individuals can be found who are fully aware, that man is so constructed, as actually to float when placed upon water, although not so superficially or in such position without great care and exertion, as to preserve an adequate entrance for air into the organs of respiration.

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* From the last line of the table published by Mr. Robertson, (Phil. Trans. vol. 50, art. 5,) we derive a knowledge of the medium of all the circumstances of height, weight, &c.; particularly the mean specific gravity, 0. 891, which is about 1-9th less than common water.

The fact, however, is, that we are calculated to float conveniently for a considerable length of time, if we are possessed of sufficient self-confidence, and some art in balancing the body. Not always long enough, it must be admitted, for complete protection against the disasters which happen on the ocean, or even on rivers and canals; on all of which such multitudes are now scattered, by the industrious and adventurous spirit of the age. Nor, in cases of shipwreck, does the casual additional support of a mast, an oar, or a plank, always suffice to lend that buoyancy, on account of their unsteadiness, which the perils of the deep often demand. More fixed appendages, of various descriptions, have lately been introduced to the notice of the public, under the appellation of life-preservers; and boats upon a similar principle, under the name of life-boats, have been constructed, so as to be secured against sinking, even when filled with water and in the most tempestuous weather, for the purpose of rescuing from destruction those "who are ready to perish."

It has happened unfortunately with respect to most of the life-preservers, as they have been termed, that some difficulty has attached to their conveyance, application, or effect, which has either rendered them useless, or much less effectual than from their principle might have been expected; and accordingly in succession they have been disregarded. The importance of the object would not allow the attempt to be abandoned, and ingenious men still continue to exercise their inventive powers, in obviating the defects of their predecessors. The buoyancy of cork, which was formerly much resorted to, has given way to the superior buoyancy of air, and jackets distended with this very light fluid, or attached vessels of other forms filled with it, have been occasionally adopted. The effort has at length been successful; and air has become, by the invention of Scheffer, in another than the acknowledged sense of the term, a perfect life-preserver.

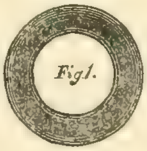


Fig.1.

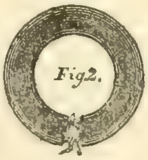
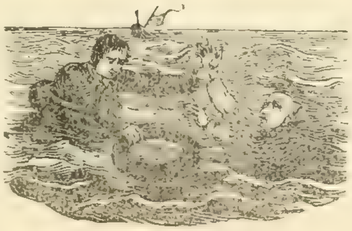


Fig.2.

Fig. 3.



The simplicity and convenience of Scheffer's Life-preserver must be at once perceived. It consists of a hollow cylinder, formed without a seam, and perfectly air-tight, bent when distended with air and ready for use, as in fig. 2: or it is what may be termed a cylindrical ring, also without a seam, and also without the break which appears in the former, represented in fig. 1. Of this ring, the external diameter is generally about 22½ inches, the internal diameter about 12, and the diameter of the part containing the air about 5½, the dimensions varying of course, by being specially adapted to the size of the person by whom it is designed to be employed. By its form, it is well fitted for the place which it occupies, being situated beneath the arms; it does not press painfully upon the chest, and the suspension or support being placed so high, enables the lower part of the body and extremities, to act as a pendulum, in keeping the wearer vertical, or restoring him to that position, if thrown aside by the force of the waves. The two holes, one in each ring, the only openings, receive a small stop-cock, to which an ivory pipe is fixed. Through this pipe the air is injected by the mouth, and retained by the stop-cock; the adjustment and inflation only occupying the short space of one minute: when unexpanded, it folds up into a very small compass, so as to be conveyed in the pocket; and is also very portable, its weight, as I ascertained by weighing one of them, being but twelve ounces.

The public at Brighton last summer, had several opportunities of seeing Scheffer supported in the sea by his very valuable contrivance. He was taken in a boat about a mile from the shore, and there threw himself into the water. He became immediately buoyant, amused himself with swimming, or allowing himself to be tossed about by the waves, for more than an hour. He had along with him a spare preserver, by which he managed to shew, that in the manner represented in the vignette, he could have placed it upon a person in danger of sinking, and even have used several for different persons in similar danger, who would all be rendered safe, until they could have been collected and preserved by a life-boat. His experiment succeeded to the satisfaction of a large number of spectators. The situation from which the exhibition was viewed, the head of the chain pier, was particularly favourable for watching the motions of the adventurer: and the sea being very rough, gave occasion to observe how effectually the buoyant girdle controlled that power, by which an unprotected man must have been speedily ingulfed.

LIFTS, certain ropes descending from the cap and mast head. Their use is to keep the yard in equilibrio, or to pull one of its extremities higher than the other, if occasion requires; but particularly to support the weight of it when a number of seamen are employed thereon to furl or reef the sail. In some merchant vessels the lifts of the topsail yards, called the topsail lifts, are also used as sheets to extend the clues of the topgallant sail. The yards are said to be squared by the lifts, when they hang at right angles with the mast, *i. e.* parallel with the horizon when the vessel is upright in the water.

LIGAMENT, in Anatomy, a strong compact substance, serving to join two bones together. A ligament is more flexible than a cartilage, not easily ruptured or torn, and does not yield, or at least very little, when pulled.

LIGATURE, in Surgery, is a cord, band, or string; or the binding any part of the body with a cord, band, fillet, &c. whether of leather, linen, or any other matter. Ligatures are used to extend or replace bones that are broken or dislocated; to tie the patients down in lithotomy and amputations; to tie upon the veins in phlebotomy, on the arteries in amputations, or in large wounds; to secure the splints that are applied to fractures; to tie up the processes of the peritonæum with the spermatic vessels in castration; and lastly, in taking off warts or other excrescences by ligature. Ligature is also used to signify a kind of bandage or fillet, tied round the neck, arm, leg, or other part of the bodies of men or beasts, to divert or drive off some disease, accident, &c.

LIGATURES, among printers, are types consisting of two letters or characters joined together; as ff, fi, fl. The old editions of Greek authors are extremely full of ligatures; the ligatures of Stephens are by much the most beautiful. Some editions have been lately printed without any ligatures at all; and there was a design to explode them quite out of printing. Had this succeeded, the finest ancient editions would, in time, have grown useless: and the reading of old manuscripts would have been rendered almost impracticable to the learned themselves.

LIGHT, is that principle or substance which renders objects perceptible to our sense of seeing. This is, perhaps, one of the most interesting subjects that falls under the contemplation of the philosopher; at the same time it must be acknowledged to be one that is as little understood, and upon which opinions are as much divided, as any of the most abstruse subjects of philosophical inquiry. Some consider light as a fluid *per se;* while others consider it merely as a principle, and attribute it to a sort of pression, or vibration propagated from the luminous body through a subtile ethereal medium. But notwithstanding the imperfection of our knowledge, with regard to the nature and cause of light, repeated experiments and observations have made us acquainted with several of its properties; such as its INFLECTION, REFLECTION, REFRACTION, &c.; for which, see the respective articles.

*Of the Motion of Light.*—The ancients considered light as propagated from the sun and other luminous bodies instantaneously; but the observations of the moderns have shewn that this was an erroneous hypothesis, and that light, like any other projectile, employs a certain time in passing from one part of space to another, though the velocity of its motion is truly astonishing, as has been manifested in various ways; and, first, from the eclipses of Jupiter's satellites. It was observed by Roemer, that the eclipses of those satellites happen sometimes sooner and sometimes later than the times given by the tables of them; and that the observation was before or after the computed times, according as the earth was near to, or farther from Jupiter, than the mean distance. Hence Roemer and Cassini both concluded that this circumstance depended on the distance of Jupiter from the earth: and that, to account for it, they must suppose that the light was about fourteen minutes in crossing the earth's orbit. This conclusion, however, was afterwards abandoned and attacked by Cassini himself. But Roemer's opinion found an able advocate in Dr. Halley; who removed Cassini's difficulty, and left Roemer's conclusion in its full force. Yet, in a memoir presented to the academy in 1709, M. Maraldi endeavoured to strengthen Cassini's arguments, when Roemer's doctrine found a new defender in Mr. Pound; see Phil. Trans. No. 136. It has since been found, by repeated observations, that when the earth is exactly between Jupiter and the sun, his satellites are seen eclipsed about eight minutes and a quarter sooner than they could be according to the tables; but when the earth is nearly in the opposite point of its orbit, these eclipses happen about eight minutes and a quarter later than the tables predict them. Hence then it is certain that the motion of light is not instantaneous, but that it takes up about sixteen minutes and a half of time to pass over a space equal to the diameter of the earth's orbit, which is near 190 millions of miles in length, or at the rate of near 200,000 miles per second; a conclusion which is placed beyond every possibility of doubt, by the aberration of the stars discovered by the celebrated Dr. Bradley.

*Of the Momentum of Light.*—We have before observed, that much diversity of opinion existed with regard to the materiality or immateriality of light, *viz.* whether it is a fluid *per se*, or whether it be merely a principle consisting in pulsations or vibrations; and thus rendered sensible to our optic nerve as sound is to our organs of hearing. The ingenious Dr. Franklin expresses his dissatisfaction with the doctrine, that light consists of particles of matter continually driven off from the sun's surface with so enormous a swiftness. "Must not," says he, "the smallest portion conceivable, have, with such a motion, a force exceeding that of a 24-pounder discharged from a cannon? Must not the sun diminish exceedingly by such a waste of matter; and the planets, instead of drawing nearer to him, as some have feared, recede to greater distances, through the lessened attraction? Yet these particles, with this amazing motion, will not drive before them, or remove, the least and slightest dust they meet with; and the sun appears to continue of his ancient dimensions, and his attendants move in their ancient orbits." He therefore conjectures that all the phenomena of light may be more properly solved, by supposing all space filled with a subtile elastic fluid, not visible when at rest, but which, by its vibrations, affects that fine sense in the eye, as those of the air affect the grosser organs of the ear; and even that different degrees of the vibration of this medium may cause the appearances of different colours. And the celebrated Euler has maintained the same hypothesis, urging some further objections to the materiality of light, beside those of Dr. Franklin, as above stated. These objections, however, Dr. Horsley took considerable pains to obviate, though some of them still remain in full force. Others, on the contrary, have attempted to prove the materiality of light, by determining the momentum of its component particles, or by shewing that they have a force so as, by their impulse, to give motion to light bodies. M. Homberg, (1708,) imagined that he could not only disperse pieces of amianthus, and other light substances, by the impulse of the solar rays, but also that by throwing them upon the end of a kind of lever, connected with the spring of a watch, he could make it move sensibly quicker; from which, and other experiments, he inferred the weight of the particles of light. And Hartsocker made pretensions of the same nature. But M. Du Fay and M. Mairan made other experiments of a more accurate kind, without the effects which the former had imagined, and which even proved that the effects mentioned by them were owing to currents of heated air produced by the burning glasses used in their experiments, or some other causes which they had overlooked. Mr. Michell endeavoured to ascertain the momentum of light with still greater accuracy, and his endeavours were not altogether without success. Having found that the instrument he used acquired, from the impulse of the rays of light, a velocity of an inch in a second of time, he inferred that the quantity of matter contained in the rays falling upon the instrument in that time, amounted to no more than the 12 hundred millionth part of a grain. In the experiment, the light was collected from a surface of about three square feet; and as this surface reflected only about the half of what fell upon it, the quantity of matter contained in the solar rays, incident upon a square foot and a half of surface, in a second of time, ought to be no more than the 12 hundred millionth part of a grain, or upon one square foot only, the 18 hundred millionth part of a grain. But as the density of the rays of light at the surface of the sun, is 45,000 times greater than at the earth, there ought to issue from a square foot of the sun's surface, in one second of time, the 40 thousandth part of a grain of matter; that is, a little more than two grains a day, or about 4,752,000 grains, which is about 670 pounds avoirdupois in 6000 years, the time since the creation; a quantity which would have shortened the sun's semidiameter by no more than about 10 feet, if it be supposed of no greater density than water only. But, after all, these experiments and computations must be considered as very vague and unsatisfactory; and it may be added, that the *material* hypothesis is almost wholly rejected by the most celebrated chemists and philosophers of the present day.

**Light**, is used in contradistinction to laden; a ship is therefore said to be light, when she has no cargo, or is not sufficiently ballasted.

**LIGHTER**, a large open flat-bottomed vessel, employed to carry goods to or from a ship.

*Ballast* **Lighter**, is a vessel fitted up to heave ballast from the bottom of a harbour or river, and to carry it to or from ships.

*Covered* or *Close* **Lighter**, is one furnished with a deck, in order to contain those merchandises which would be damaged by accidental wet, as also to prevent pillage.

**LIGHT-HOUSE**, a sort of tower erected upon a headland or point on the sea coast, or upon some rock in the sea, and having a great fire or light, formed by candles, &c. upon its top, in the night time, which is constantly attended by some careful person, so as to be seen at a great distance from the land. Its use is to direct the shipping on the coast, that might otherwise run ashore, or steer an improper course. The two most celebrated light-houses on the coast of Great Britain, are the *Eddystone* and *Bell-rock Light:* the former erected by the celebrated Smeaton. We have, under the word Pharos, given the details of the erection and peculiar construction of the latter, which was executed by Robert Stevenson, Esq. from a model, and of the same dimensions, of the Eddystone, with the improvements on lighting which the recent progress in optics allowed the engineer to make.

*Floating* **Light**, differs from the preceding by its being erected on board a vessel which is strongly moored upon a sand or shallow, to warn ships from approaching too near it.

**LIGHTNING.** It is now universally allowed, that lightning is really an electrical explosion or phenomenon. Philosophers had not proceeded far in their experiments and inquiries on this subject, before they perceived the obvious analogy between lightning and electricity, and they produced many arguments to evince their similarity. But the method of proving this hypothesis was first proposed by Dr. Franklin, who, in the year 1749, conceived the practicability of drawing lightning from the clouds. *See* Meteorology and Electricity.

**LIGHTROOM**, in a ship of war, a small apartment, having double glass windows towards the magazine. It is used to contain the lights by which the gunner and his assistants are enabled to fill their cartridges with powder, to be ready for action. Large ships of war generally have two lightrooms, *viz.* the after lightroom, attached to the after magazine; and the fore lightroom, which gives light to the fore or great magazine.

**LIGNUM Vitæ.** The lignum vitæ tree is a native of the West Indies, and the warmer parts of America: it rises to the height of forty feet, and measures from fifteen to eighteen inches in diameter; having a hard, brittle, brownish bark, not very thick. The wood is firm, ponderous, resinous, of a blackish yellow colour in the middle, and a hot aromatic taste.

**LIGULATED**, among botanists, an appellation given to such floscules as have a straight end turned downwards, with three indentures, but not separated into segments.

**LIGUSTICUM**, *Lovage*, a genus of plants belonging to the pentandria class; and in the natural method ranking under the 45th order, umbellatæ.

**LIGUSTRUM**, *Privet*, a genus of plants belonging to the diandria class; and in the natural method ranking under the 44th order, sepiariæ.

**LIMB**, the outermost border, or graduated edge, of a quadrant, astrolabe, or such like mathematical instrument. The word is also used for the arch of the primitive circle, in any projection of the sphere in plano. Limb also signifies the outermost border or edge of the sun and moon; as, the upper limb or edge, the lower limb, the preceding limb or side; the following limb. Astronomers observe the upper or lower limb of the sun or moon, to find their true height, or that of the centre, which differs from the others by the semidiameter of the disc.

**LIMBERS**, or Limber Holes, square holes cut through the lower part of a ship's floor timbers, very near the keel, forming a channel for water, and communicating with the pump well throughout the whole length of the floor. Every floor timber has two such holes cut through it, one on each side of the keelson.

Limber *Boards*, short pieces of plank, which form a part of the lining of a ship's floor close to the keelson, and immediately above the limbers. They are occasionally removed to clear the limbers of any filth by which they may be clogged, so as to interrupt the passage of the water to the pump well.

Limber *Rope*, a long rope frequently retained in the limber holes of a ship, in order to clear them, by pulling the rope backwards and forwards, so as to loosen any dirt by which they may be choked.

**LIME**, one of those earthy substances, which exist in every part of the known world; it is found purest in limestone, marble, and chalk. None of these substances are lime, but are capable of becoming so by burning in a white heat. It may be also obtained perfectly pure by burning calcareous spars, and also by burning some pure white marbles. It may be procured also in a state of purity by dissolving oyster-shells in muriatic acid. It has been ascertained by Sir H. Davy to consist of oxygen and a metallic basis which he denominates calcium.

**LIMESTONE.** The native indurated carbonate of lime.

**LIMIT**, is a term used by mathematicians for some determinate quantity, to which a variable one continually approximates, and may come nearer to it than by any given difference, but can never go beyond it; in which sense a circle may be said to be the limit of all its inscribed and circumscribed polygons; because these, by increasing the number of their sides, can be made to be nearer equal to the circle than by any space that can be proposed, however small it may be.

**LIMNING**, the art of painting in water colours, in contradistinction to painting, which is done in oil colours. Limning is much the more ancient kind of painting. Till a Flemish painter, one John van Eyck, better known by the name of John of Bruges, found out the art of painting in oil, the painters all painted in water and in fresco, both on their walls, on wooden boards, and elsewhere. When they made use of boards, they usually glued a fine linen cloth over them, to prevent their opening; then laid on a ground of white; lastly, they mixed up their colours with water and size, or with water and yolks of eggs, well beaten with the branches of a fig tree, the juice whereof thus mixed with the eggs; and with this mixture they painted their pieces. In limning, all colours are proper enough, except the white made of lime, which is only used in fresco. The azure and ultramarine must always be mixed with size or gum; but there are always applied two layers of hot size before the size colours are laid on: the colours are all ground in water each by itself; and, as they are required in working, are diluted with size water. When the piece is finished, they go over it with the white of an egg well beaten; and then with varnish, if required.

*To Limn*, or *Draw a Face in Colours.* Having all the materials in readiness, lay the prepared colour on the card even and thin, free from hairs and spots, over the place where the picture is to be. The ground being laid, and the party placed in a due position, begin the work, which is to be done in three sittings. At the first, you are only to dead-colour the face, which will require about two hours. At the second sitting, go over the work more curiously, adding its particular graces or deformities. At the third sitting, finish the whole, carefully remarking whatever may conduce to render the piece perfect, as the cast of the eyes, moles, scars, gestures, and the like.

**LINE**, in Geometry, is, according to Euclid's definition, that which has length without thickness. Lines are either right or curved: A *Right* or *Straight* Line, is that which lies all in the same direction between its extremes or ends. A *Curve* Line, is that which continually changes its direction. *Curve* Lines, are again divided into *algebraical*, *geometrical*, and *mechanical*, or *transcendental*. An *Algebraical* or *Geometrical* Line, is that which may be expressed, that is, the relation between its absciss and ordinate, by an algebraical equation. And such lines are divided into orders, according to the dimensions of the equations by which they are represented. *Mechanical* and *Transcendental* Lines, are those which cannot be expressed by finite algebraical equations. Besides the above distinctions, lines receive other denominations according to their absolute or relative positions, as *parallel*, *perpendicular*, *oblique*, *tangential*, &c.; for which see the respective terms. Lines have again other distinguishing appellations, as they are introduced into the different sciences of astronomy, geography, dialling, perspective, &c.; as, Line of the *Apsides*; of the *Nodes*; *Horizontal*, *Hour*, *Equinoctial*, &c. *Lines*; each of which will be found illustrated under the respective articles.

Line also denotes a French measure of length, being the 12th part of an arch.

**LINE**, a general name given to the arrangement or order in which a fleet of ships of war are disposed to engage an enemy. This disposition, which is the best calculated for the operations of naval war, is formed by drawing up the ships in a long file, or right line, prolonged from the keel of the hindmost to that of the foremost, and passing longitudinally through the keels of all the others from the van to the rear, so that they are, according to the sea phrase, in the wake of each other.

In the line or order of battle, all the ships in which it is composed are close-hauled upon the starboard or larboard tack, about fifty fathoms distant from each other. A fleet is more particularly drawn up in the line when in presence of an enemy. It ought to be formed in such a manner as that the ships should mutually sustain and reinforce each other, and yet preserve a sufficient space in their stations, to work or direct their movements with facility during the action. Thus they will be enabled effectually to cannonade the enemy, without incommoding the ships of their own squadron. In a line of battle, the weathermost fleet, or that which, in sea language, has the weather gage, is generally allowed to have the advantage, although there are several arguments on the other hand in favour of the leeside; accordingly, we shall endeavour to state the mutual advantages and disadvantages.

*Advantages of the Weather Gage.*—1. The weather gage is the sooner clear of smoke; and of course, that line can better observe the signals which are spread than the ships to leeward can, which must have the continuance of both its own smoke and that of the enemy longer. 2. If the weather ships are more in number than the enemy's, they can detach some from their squadron, which bearing down upon the rear of the enemy, must infallibly throw them into disorder. 3. The fireships of the weather line can, when they are ordered, more easily bear down upon the enemy, than those of the lee can ply to windward, which can never be done against a line in action: but the weather fireships can bear down against all the resistance that can be made by the enemy.

*Advantages of the Lee Line.*—1. If one, two, or more of the ships to windward should be disabled, they must inevitably drive to leeward, and become a prey to the enemy. 2. The ships of the lee line can more readily bear away before the wind, and have their places supplied by ships from the corps-de-reserve, in case of being disabled, or meeting with any disaster. 3. The line to leeward can keep their ports longer open in a strong wind with a high sea, when those to windward in all probability may be obliged to shut the ports of their lower tier of guns, to prevent the water from rushing in between decks, which may be attended with the most fatal consequences. 4. The lee line can more easily observe the men on the decks of the ships to windward, as they heel, and when the smoke does not intercept their sight; at which time the marines and topmen may easily take aim at and destroy them with muskets and carabines.

The disadvantages of the weather line sometimes counterbalance the advantages above recited, *viz.* 1. If the sea is rough, and the wind boisterous, it cannot readily fight with the lower deck guns. 2. The weather line cannot decline the action without the dangerous expedient of forcing through the enemy's line, and if it keeps the wind, the lee line may enclose and totally destroy it, especially if it is inferior in numbers to the latter; or if the ships thereof are in a bad condition, for it then can find no other resource but in the dexterity of its manœuvres, unless it is favoured by the wind, or any oversight of the enemy. 3. The disabled ships of the weather line must tack, to avoid falling into the enemy's fleet; and if they are much shattered, they may be altogether separated, particularly if they are in the rear of the line.

*The defects of the Lee Line are,*—1. It cannot decide the time and distance of the battle, which may commence before it is sufficiently formed, and it will perhaps be attacked by an enemy who bears away upon it in regular order. 2. It suffers much inconvenience from the fire and smoke of the weather-line, as remarked in the advantages of the weather line (1.) It cannot easily break the enemy's line with its fire-ships, which are slowly and with difficulty conveyed to windward. On the contrary, the fire-ships of the weather line have a considerable advantage (3.)

The line of a fleet, which has abundance of capital ships, need not be so much enclosed as that of an enemy who has fewer. An open line will, on many occasions, work more easily than one which is more enclosed; and if it is less numerous, the movements thereof are more expeditious, the signals better attended to, the general orders more exactly observed, and the ships less liable to be separated. Hence it will be less embarrassed by a change of wind, and order will be sooner re-established. A less numerous line will more readily approach or escape from an enemy or an hostile shore, and finally, when cruising in a smaller space, it will not be so much contracted. It must be remarked, that the admiral's ship attentively preserves her station in the centre of the line; for if the commander in chief should give way to the caprice or inattention of any of those under his direction, it would introduce an endless disorder into his squadron.

**Line**, is also the general appellation of a number of small ropes in a ship, as

*Concluding* **Line**, a small rope which is hitched to the middle of every step of a stern ladder.—*Deep Sea* **Line**, a long line, marked at every five fathoms with small strands of line knotted. It is used with the deep-sea lead.—*Fishing* **Line**, a particular kind of line generally used for fishing.—*Hand* **Line**, a line about 20 fathoms long, marked with black leather, white rag, and red bunten, at different distances. It is made fast to a hand lead, and used to determine the depth of water in going in or out of harbour, river, channel, &c.—*Hauling* **Line**, any rope let down out of a top, &c. to haul up some light body by hand.—*Knave* **Line**, a rope fastened to the cross-trees, under the main or fore top, whence it comes down by the ties to the ram-head, and there it is reeved through a piece of wood of about two feet long, and so is brought to the ship's side, and there hauled up taught to the rails.—*Life*-**Line**, a rope occasionally extended in several situations for persons to lay hold of, to prevent their falling.—*Naval*-**Line**, a rope depending from the heads of the main and fore masts, and fastened to the middle of the truss, to keep it up whilst the yard is being swayed up. *Spilling* **Lines**, ropes fixed occasionally to the square-sails, particularly the main and fore courses of a ship in tempestuous weather, for reefing or furling them more conveniently; they are received through blocks upon the yard, whence leading round the sail, they are fastened behind to the yard, so that the sail is by their efforts very closely confined.—*White*-**Line**, implies that which has not been tarred, in contradistinction to tarred line.—*Mar*-**Line**, is a particular kind of small line, composed of two strands very little twisted; there is both tarred and white mar-line.

**LINEN**, in Commerce, a well-known kind of cloth, chiefly made of flax. Linen was not worn by the Jews, Greeks, or Romans, as any part of their ordinary dress. Under-tunics of a finer texture supplied the place of shirts: hence the occasion for frequent bathing. Alexander Severus was the first emperor who wore a shirt: but the use of so necessary a garment did not become common till long after him. In Egypt, indeed, the linen manufacture appears to have been very early; for even in Joseph's time it had risen to a considerable height. From the Egyptians the knowledge of it proceeded probably to the Greeks, and from them to the Romans. Even at this day, the flax is imported among us from the eastern nations; the western kind being merely a degenerate species of it. In order to succeed in the linen manufacture, one set of people should be confined to the ploughing and preparing the soil, sowing and covering the seed, to the weeding, pulling, rippling, and taking care of the new seed, and watering and dressing the flax till it is lodged at home: others should be concerned in the drying, breaking, scutching, and hackling the flax, to fit it for the spinners; and others in spinning and reeling it, to fit it for the weaver: others should be concerned in taking due care of the weaving, bleaching, beetling, and finishing the cloth for the market. It is reasonable to believe, that if these several branches of the manufacture were carried on by distinct dealers in Scotland and Ireland, where our home-made linens are manufactured, the several parts would be better executed, and the whole would be afforded cheaper, and with greater profit.

*Staining of Linen.*—Linen receives a black colour with much more difficulty than woollen or cotton. The black struck on linen with common vitriol and galls, or logwood, is very perishable, and soon washes out. Instead of vitriol, a solution of iron in sour strong beer is to be made use of. This is well known to all the calico-printers; and by the use of this, which they call their iron-liquor, and madder root, are the blacks and purples made, which we see on the common printed linens. The method of making this iron-liquor is as follows: A quantity of iron is put into the sour strong beer; and to promote the dissolution of the metal, the whole is occasionally well stirred, the liquor occasionally drawn off, and the rust beat from the iron, after which the liquor is poured over again. A length of time is required to make the impregnation perfect; the solution being reckoned unfit for use, till it has stood at least a twelvemonth. This solution stains the linen of a yellow, and different shades of buff-colour; and is the only known substance by which these colours can be fixed in linen. The cloth stained deep with the iron-liquor, and afterwards boiled with madder, without any other addition, becomes of the dark colour which we see on printed linens and cottons; which, if not a perfect black, has a very near resemblance to it. Others are stained paler, with the same liquor diluted with water, and come out purple. Linen may also be stained of a durable purple by means of a solution of gold in aqua regia. The solution for this purpose should be as fully saturated as possible; it should be diluted with three times its quantity of water; and if the colour is required deep, the piece, when dry, must be repeatedly moistened with it. The colour does not take place till a considerable time, sometimes several days, after the liquor has been applied: to hasten its appearance, the subject should be exposed to the sun and free air, and occasionally removed to a moist place, or moistened with water. When solution of gold in aqua regia is soaked up in linen cloths, the metal may be recovered by drying and burning them.

*Fossile* **Linen**, is a kind of amianthus, which consists of flexible, parallel, soft fibres, and which has been celebrated for the use to which it has been applied, of being woven, and forming an incombustible cloth. Paper also, and wicks for lamps, have been made of it.

**LINIMENT**, in Pharmacy, a composition of a consistence somewhat thinner than any unguent, and thicker than an oil.

**LINSTOCK**, a staff about three feet long, having a sharp point at one end, and a sort of fork or crotch in the other; the latter serves to contain a lighted match, and by the former, the linstock is occasionally stuck in the deck in an upright position. It is frequently used in small vessels in an engagement, where there is commonly one fixed between every two guns, by which the match is always kept dry and ready for firing.

**LINT**, in Surgery, is the scrapings of fine linen, used by surgeons in dressing wounds. It is made into various forms, which acquire different names according to the difference of the figures. Lint, made up in an oval or orbicular form, is called a pledgit; if in a cylindrical form, or in shape of a date or olive stone, it is called a dossil. These different forms of lint are required for many purposes; as, 1. To stop blood in fresh wounds, by filling them up with dry lint before the application of a bandage: though, if scraped lint be not at hand, a piece of fine linen may be torn into small rags, and applied in the same manner. In very large hæmorrhages, the lint or rags should be first dipped in some styptic liquor, as alcohol, or oil of turpentine; or sprinkled with some styptic powder. 2. To agglutinate or heal wounds; to which end, lint is very serviceable, if spread with some digestive ointment, balsam, or vulnerary liquor. 3. In drying up wounds and ulcers, and forwarding the formation of a cicatrix. 4. In keeping the lips of wounds at a proper distance, that they may not hastily unite before the bottom is well digested and healed. 5. They are highly necessary to preserve wounds from the injuries of the air.—Surgeons of former ages used compresses of sponge, wool, feathers, or cotton, linen being less plentiful than in later times: but lint is far preferable to all these, and is at present universally used.

**LINUM** Usitatissimum. Flax, or *Lint Seed*.—Is grown for the purpose of making cloth, and has been considered a very profitable crop. The culture and management is similar to that of hemp, and the seeds are in great demand for pressing. Lintseed oil, which it produces, is much used by painters, and is the only vegetable oil that is found fit for such purposes in general. The seeds are of several uses to the farmer; a tea is made of it, and mixed with skimmed milk, for fattening house-lambs and calves. Oxen are often fattened on the seed itself; but the cakes, after the oil is expressed, are a very common and most excellent article for fattening both black cattle and sheep. These are sold at from £10 to £16 per thousand. It will require three bushels of flax-seed for one acre, as it must be sown thick on the land. Linseed cake has been used also for manure; and I have seen fine crops of turnips, where it has been powdered, and sown in the drills with the seed.

**LIQUORICE.** The glycyrrhiza, or common liquorice shrub, has a long, thick, creeping root, striking several feet deep into the ground; an upright, firm, herbaceous, annual stalk, three or four feet high, garnished with winged leaves, of four or five pair of oval lobes, terminated by an odd one; and from the axillas, erect spikes of pale blue flowers in July, succeeded by short smooth pods. The root of this plant is the useful part, being replete with a sweet, balsamic, pectoral juice, which is either extracted, or the wood sold in substance. It is much used in all compositions for coughs, and disorders of the stomach; but by far the greatest quantity is used by brewers. The common liquorice is cultivated in most countries of Europe, for the sake of its root; but in Spain and Italy, and particularly in Sicily and Calabria, it makes a considerable article of commerce with this country. Liquorice also grows in great abundance in the Levant; and vast quantities of it are consumed there, in making a decoction which is drunk cold in the summer, in the manner of sherbet. To prepare liquorice, the roots are boiled a long time in water, till the fluid has got a deep yellow tincture; and the water at length evaporated till the remains acquire a consistency, when they are formed into sticks, which are packed up with bay leaves, in the same order as we receive them. The boiling requires the utmost care and precaution, as the juice takes an unpleasant smell and flavour, if burnt in the least degree.

**LIST**, Civil, in the British polity. The expenses defrayed by the civil list are those that in any shape relate to civil government; as, the expenses of the household; all salaries to officers of state, to the judges, and every one of the king's servants; the appointments of foreign ambassadors; the maintenance of the queen and royal family; the king's private expenses, or privy purse; and other very numerous out-goings, as secret-service money, pensions, and other bounties; which sometimes have so far exceeded the revenues appointed for that purpose, that application has been made to parliament to discharge the debts contracted on the civil list.

*To* List, or Enlist Soldiers, to retain and enroll men as soldiers, either as volunteers, or by a kind of compulsion. Persons listed, must be carried within four days, but not sooner than twenty-four hours after, before the next justice of peace of any county, riding, city, or place, or chief magistrate of any city or town corporate, (not being an officer in the army,) and if, before such justice or magistrate, they dissent from such enlisting, and return the enlisting money, and also twenty shillings in lieu of all charges expended on them, they are to be discharged. But persons refusing or neglecting to return and pay such money within twenty-four hours, shall be deemed as duly listed as if they had assented thereto before the proper magistrate; and they shall, in that case, be obliged to take the oath, or, upon refusal, they shall be confined by the officer who listed them till they do take it.

List, in Commerce, the border of cloth or stuff; serving not only to shew their quality, but to preserve them from being torn in the operations of fulling, dyeing, &c. List is used on various occasions; but chiefly by gardeners, for securing their wall trees.

List, in Architecture, a little square moulding, otherwise called a fillet, listel, &c. *See* Architecture.

List, is also used to signify the enclosed field or ground wherein the ancient knights held their justs and tournaments. It was so called, as being hemmed round with pales, barriers, or stakes, as with a list. Some of these were double, one for each cavalier; which kept them apart, so that they could not come nearer each other than a spear's length. *See* Just, Tournament, Duel, &c.

List, implies an inclination to one side, as, The ship has a list to port, *i. e.* is depressed more in the water on that side.

**LITANY**, a solemn form of supplication to God, in which the priest utters some things fit to be prayed for, and the people join in their intercession, saying, "We beseech thee to hear us good Lord," &c. The word comes from the Greek "supplication." Before the last review of the common prayer, the litany was a distinct service by itself, and used some time after the morning prayer was over; at present it is made one office with the morning service, being ordered to be read after the third collect for grace, instead of the intercessional prayers in the daily service.

**LITHOGRAPHY.** Lithography, or the art of taking impressions from drawings or writings made on stone, is quite a modern invention. It, unlike letter-press or copperplate printing, which are altogether mechanical processes, depends entirely upon chemical principles, and has therefore been called in Germany, chemical printing. The principles on which it is founded are, first, the quality which a compact granular limestone has of imbibing grease or moisture; and secondly, the decided antipathy of grease and water for each other. A drawing is made on the stone, either with ink or with a crayon of a greasy composition; it is then washed over with water, which sinks into those portions of the stone which are untouched with the grease of the drawing. A cylindrical roller, charged with printing ink, is then passed all over the stone; and, while the drawing receives the ink, the rest of the stone is preserved from it by the water, on account of the greasy nature of the ink.

This useful art was invented by mere accident. Alois Senefelder, the son of a performer at the theatre royal, Munich, a student of jurisprudence in the university of Ingoldstadt, after the death of his father, took likewise to the stage; but, being unsuccessful in his pursuit of it, he afterwards became an author. Poverty was indeed, in him, the mother of invention; for being too poor to publish his works, he tried various plans, with copperplates and compositions, as substitutes for letter-press, that he might thus become his own printer. In the course of his experiments he found that a composition of soap, wax, and lamp black, formed an excellent ink for writing with on plates; as, when dry, it became firm and hard, and resisted aquafortis. He wanted facility, however, in writing backwards on the plates, and that he might practise this at less expense, he procured some pieces of Kilheim stone, as a cheap material, on which, after polishing their surfaces, he might practise. Having been desired by his mother to take a list of some linen about to be sent to be washed, and having no paper at hand, he wrote it out on a piece of stone with his composition. When he was afterwards about to efface his writing, it occurred to him that impressions might be obtained from it; and, after he had eaten away the stone with an acid, for about the hundredth part of an inch, he found that he could easily take successive impressions. It appeared to him, that the new mode of printing was of very considerable importance; and he therefore, through great difficulties, persevered in improving it, and in attempting its application to practical purposes.

He soon found that it was not necessary to have the letters raised above the stone; but that the chemical properties which keep grease and water so effectually separate from each other, were quite sufficient for his purpose. He afterwards bestowed much labour and assiduity in constructing the proper press, and other apparatus, for printing. The first essays to print for publication, were some pieces of music executed in 1796; afterwards he attempted drawings and writings. He still, however, found great difficulty in writing backwards, and this led him to think of the process of transfer; and the use of dry soap, which was found to leave permanent traces which would give impressions, naturally led to the mode of chalk drawings.

In 1799, after having made many improvements, Mr. Senefelder obtained a patent privilege for Bavaria. He then made known his invention to Mr. Andre, of Offenbach, with whom he entered into partnership, and proposed to establish printing offices, and take out patents at London, Paris, and Vienna. In order to establish presses in England, Senefelder came to London with a brother of Mr. Andre's; and most of the English artists made trial of the art. But, unfortunately, it was not then fully understood; and the difference of materials of Germany and those of England, used both for the purposes of drawing and printing, caused constant failures, and the artists in succession abandoned it.

An attempt was made, in 1800, by Senefelder alone, to establish presses in Vienna; and after great difficulty, a patent was obtained; but bad management, and some unfortunate circumstances, prevented its succeeding, and he returned to Munich in 1806, leaving the establishment which he had formed in other hands.

In 1806, Mr. Mitterer, professor of drawing in the public school at Munich, practised lithography to obtain copies for his pupils. He is said to have invented the chalk composition in its present form, or at least to have improved it greatly. The practice of the art now began rapidly to extend and improve, more particularly at Munich, where several establishments were formed for the purpose of applying it to the fine arts, as well as for printing writings and official forms for the different departments of the government. In 1809, Senefelder was appointed inspector of the royal lithographic establishment at Munich, from printing from stone a complete map and survey of Bavaria; since which period he has devoted his time to experiments, and to writing the history of his invention. In England it can hardly be said to have been entirely given up from the time of its first introduction in 1800, yet it was little practised or thought of after 1806, until it was revived in 1817. Since this, it has been more generally attended to, and some of the establishments having now become well acquainted with the process of printing, specimens have been produced in England equal to those of any other country. In France but little was done in lithography till 1815, when it was established in Paris, by Lasteyrie; and, being taken up by good artists, it soon attained great excellence. About the same time it extended to Russia and other parts of Europe.

*The Stones, and the manner in which they are prepared to receive the Drawings.*—The stone most used in England is found at Corstan, near Bath. It is one of the white lias beds, but not so fine in grain, nor so close in texture, as the German stone, and, therefore, far inferior. But it is good for transfers, and does tolerably well for ink drawings or writings. Another stone is also used, found near Stony Stratford; but it is of a brownish gray tint, and too dark in colour to shew the effect of the drawing with sufficient clearness. All calcareous stones can be used in lithography, because they will all imbibe grease and moisture, but those are best adapted to it which are very compact, of a fine equal grain, and free from veins, or imbedded fossils or crystals. The stones first used were obtained from the quarries of Solenhofen, near Pappenheim, in Bavaria, and none have ever been obtained to equal them. In France, stones have been found near Chateauroux, of a similar colour to these, and even harder, and of a finer grain; but full of large spots of a softer nature.

In order to sustain the pressure used in taking impressions, a stone 12 inches square, must be 1¼ inch thick; and the thickness must increase with the size of the stone. The stones are first sawn to a proper size, and are then ground smooth and level by rubbing two of them, face to face, with water and sand. They must be very carefully examined with a straight-edge, to ascertain that they are perfectly level in all directions. This applies only to the side which is afterwards to receive the drawing, as the natural division of the stone is sufficiently true for the back.

When the stones have been thus ground perfectly level, they are well washed, to free them from any of the coarser grains of sand which may have been used in smoothing them; and they are then placed on a board over a trough, and again they are rubbed face to face with sand and water, though the sand now used must be of a much finer texture than the sand previously used. The greatest care must be taken to have the sand sufficiently fine; and for this purpose it must be sifted through a small close sieve, as a single grain of sand, of a coarser texture than the rest, will scratch the stone, and these scratches will afterwards appear in the impressions taken from the stone. When the stones have been rendered sufficiently fine, and their grain sufficiently smooth, they must then be carefully washed and then wiped dry with a clean soft cloth. This is the plan adopted to prepare the stones for chalk drawings; but to prepare them for ink drawings or writings, the following method is the best; After the process just described has been gone through, the stones are well washed, to get rid of the sand, and they are then rubbed two together, face to face, with powdered pumice-stone and water. After they are made perfectly smooth, they are again washed and wiped dry, and are then separately polished with a large piece of pumice-stone.

*In order to clean the Stones after they have been fully used.*—Sand is strewed over the surface, and it is sprinkled with water, and rubbed with another stone, until the writing or drawing upon it has completely disappeared. It must then be washed with aquafortis diluted in twenty times its bulk of water; and the stone is then prepared for a new drawing or writing by being rubbed with fine sand or pumice stone as before. The longer drawings remain on stones, the deeper the ink or the chalk penetrates into their substance, and consequently the more of the stone must be ground away to remove them; this is also more necessary with ink drawings than with chalk ones, because ink penetrates much deeper into the stone than chalk.

The stones being thus prepared, it is necessary now to enter upon the substances which are used for drawing or writing upon them. These are *Lithographic Ink*, or *Chalk*. A great many different receipts have been given for making Lithographic ink, and out of these we shall give the best. Two kinds of ink are necessary—that for writing on the stones, and that for making transfers. The best composition which we have seen for ink for writing is the following;

*Composition of Lithographic Ink for Drawing on the Stone.*—Two ounces of the tallow of candles; two ounces virgin wax; two ounces shell lac; two ounces common soap; and of lamp black nearly about a twentieth part of the whole. These materials must be prepared in an iron saucepan having a cover; the wax and tallow are first put in, and are heated till they take fire; while they are burning, the soap is thrown in, in separate pieces one at a time, care being taken that one be melted before another is thrown in. When the whole soap has been added, the composition must be allowed to burn until it has lost about a third of its quantity. After this, the shell lac is added; and, as soon as it is melted, the flame must be extinguished. After being allowed to cool, it should now dissolve, (though it will do so but slowly,) by rubbing it in warm water. The lamp black, which must be of the finest quality, is now to be mixed with it, which is done while it is melted over a slow fire, adding small portions of the black at a time, and stirring them well together. When the ink is made, and cold, its fracture should have the appearance of Indian ink, though in its substance it is softer. After being completely melted and mixed with the black, it should be run on a marble slab, and a heavy weight placed above it, in order to press it.

After very careful management, the ink will be sometimes found defective; this, however, must proceed from something being wrong with the ingredients, or the manner of their preparation; but, as it is impossible to prevent imperfections, it will be as well to mention a few of those which most commonly occur, with the remedies to be used to remove them.

*Defects of the Ink, and Remedies to be used.*—1st. The ink will at times be found insoluble. The proper remedy, in this case, is to add more soap, in the same manner it was first added. Although the ingredients are to be melted over a fire, in order to have the additional soap mixed with them, they must not be allowed to take fire, as was the case when the soap was first added. 2d. It is sometimes too soft, and attaches itself to the fingers. When this happens, it must again be put into the saucepan, and burned till it gets to a proper consistence.

3d. We find a defect of almost all inks to be, that, some time after dissolving them in water, they become thick and slimy, and require a continual addition of water before we are enabled to draw with it. This is solely owing to its not being sufficiently burnt; and of course the only remedy is, as in the former case, to burn it more. 4th. If the ink is not compact, but full of bubbles, it has been cast too hot on the marble slab. It must therefore be re-melted, cast again when it is less hot, and a heavier weight must be placed upon it. 5th. On other occasions the ink will be found to have no tenacity, and seem to be composed of scorias. When this is the case, it has been either too much burnt, or contains too much black; in either case, add equal portions of wax and soap, and melt it again over a slow fire.

The only other ink we have mentioned, as being necessary in lithographic drawing or printing, is

*Ink for making Transfers.*—This ink is composed of the very same materials as the ink for writing or drawing; but they must be less burned. It will thus be softer, and it must also be afterwards melted and mixed with a little more wax and thick varnish, such as those we shall mention when we come to speak of the printing ink.

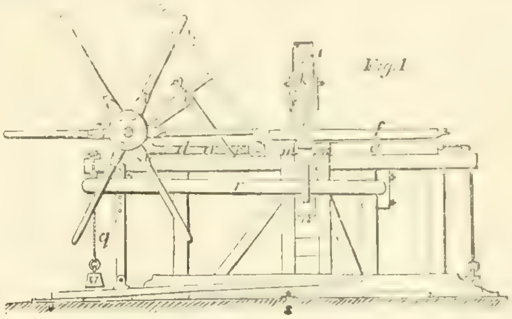
*Lithographic Chalk.*—Besides the inks, we have already mentioned that chalks are used for drawing. Good lithographic chalk ought to have all the qualities of a good drawing crayon. It should be even in texture, and should carry a good point. The best proportions for its composition are the following: an ounce and a half of common soap; tallow two ounces; virgin wax two and a half ounces; shell lac one ounce. The rest of the process is the same as in making the ink. Less black should be mixed with the chalk than with the ink, its only use being to colour the drawing, that the artist may see the lines he traces. When the whole is well mixed, it should be poured into a mould, and very strongly pressed, to prevent any bubbles which would make the texture irregular. Now that we have described the preparation of the stone, and of the inks and chalk necessary for drawing, we must next proceed to notice the

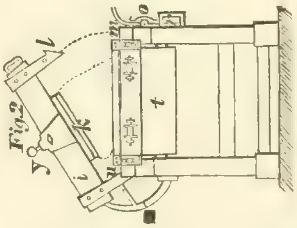
*Mode of Drawing.*—Previous to drawing or writing, the stone must be well wiped with a clean dry cloth. The ink is rubbed with warm water like Indian ink, and must be used on the *polished* stone, while the chalk, which would not hold upon it, must be used on the ground stone. A gradation of tints, in drawing with the ink, can easily be obtained by merely varying the thickness of the line, and the distance at which they are placed apart; for the line traced by the ink being sound and unbroken throughout, receives the printing all over. It is thus plain that no advantage can be obtained by diluting the ink for the purpose of varying the tints of the lines; and the great object of the artist ought therefore to be, to have his ink of the proper consistency, which will stand best throughout the process of printing. A consistency a little stronger than common writing ink will be sufficient for this purpose.

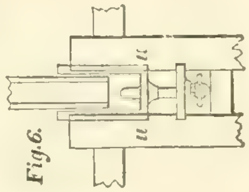
When the chalk is to be used, the ground stone must be cleaned of all dust, and it is then drawn upon with the chalk in the same manner as crayons are used on paper. It is proper that the strength of the tint which is wished should be given at once, as the surface of the stone is altered by receiving the chalk, and it will not receive new lines equally well; and the strength of the tint will be regulated by the pressure of the hand. Nothing but practice ever gives the necessary command of the material, which undoubtedly does not work quite like the common crayon, there being great difficulty in keeping a good point. There is likewise considerable trouble in obtaining the finer tints sound in the impression; and in order to obtain the lighter tints properly, it will be necessary to put the chalk in a rest, as the metal port crayon is too heavy to draw them, even although there is no pressure of the hand used. Several pieces of chalk should be prepared, to use in succession, as the warmth of the hand softens it. It is useful to cut the chalk to the form of a wedge rather than a point, as it is less likely to bend in that form. Small portions sometimes break off during the drawing; these must be carefully removed with a brush.

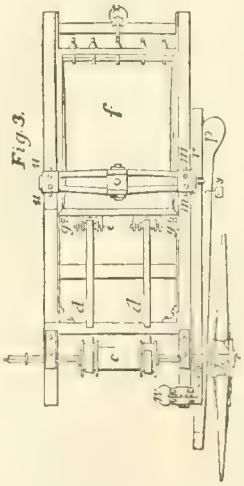
We now proceed to describe the press and rollers used, with the maner of printing. That given in the engravings is certainly the best we have ever seen, although there are different forms in use.

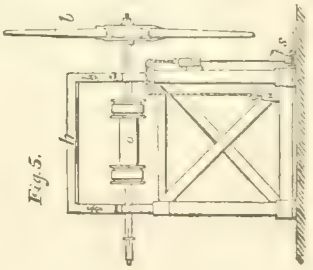
Fig. 1, is a side elevation of the press, with the scraper partly down. Fig. 2, a cross section through the middle. Fig. 3, a horizontal plan of the upper part. Fig. 4, detail of the manner in which the scraper is held down during the impression.











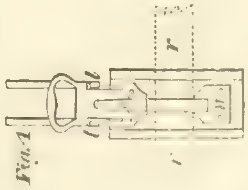


Fig. 5, end elevation of the press. Fig. 6, to explain the manner in which the centre of motion of the scraper is raised and lowered.

The press consists of a strong frame, having on the upper part a platten or bed, *a*, to receive the stone, and which is moved along grooves in the upper part of the frame by means of a star-wheel *b*, to the axis of which is fixed a cylinder *c*. On this cylinder the straps *d*, *d*, are gathered, which work over the pulleys *e*, fixed to the bed. When the stone is placed on the bed, and ready for the impression, the frisket, or cover, *f*, of the bed, is brought down from the position marked by the dotted outline in fig. 1, and shut over the stone, as shewn in the same figure. This cover consists of a strong piece of calf's skin, stretched by screws with nuts and hooks, which catch hold of an iron rod sewed along one end of the skin. The other end of it is fixed to the opposite end of the frame. (See fig. 3.) The cover is fixed to the bed by hinges, *g*, which can be screwed at different heights, according to the thickness of the stones. When the cover is opened, it rests against the frame *h*, which can be adjusted to different heights. (See figs. 1 and 5.)

The cross piece *i*, having the scraper *k* fixed in it, is now brought down, and the catches *l* lock into the upper part of the piece *n*, sliding between the grooved upright *m*. This is shewn more in detail in fig. 4; the upper part where the catches lock, is of iron, and has a joint and handle to pull it out when the scraper is to be unlocked. A spring *o*, keeps it generally in an upright position to be ready to hold the catches *l*, *l*. When the scraper is locked down, the printer sets his foot on the treadle *p*, of the lever, which presses the scraper with great power on the stone. The pressure is by a double lever, having a connecting rod *q*, which can be adjusted so as to bring the upper arm *r* nearer to the treadle, when an increase of pressure is required, or a thinner stone is placed on the bed, which makes it necessary to bring the scraper lower down. The arm *r* passes through an iron frame on the sliding piece *n*, and thus brings it down when the treadle is depressed. The hook *s* holds down the treadle during the impression.

The star wheel *b* is now turned round, and by this motion the bed is drawn under the scraper, and the impression is taken. The bed passes over a roller *t*, which is placed with its centre directly under the scraper. (See fig. 2.) As the stones are not always of the same thickness, the scraper must be brought to different heights. Fig. 6, shews an adjusting screw for the purpose of regulating the end farthest from the catches, there being a sliding piece between the grooved uprights *u*, in which the centre is fixed, on which the cross piece *i* turns. The iron *v*, fig. 2, stops the cross piece and scraper from falling back. When the bed has been drawn out, the printer releases the treadle, which is raised up by the balance weight *w*, and the scraper being unlocked and thrown back, the bed is drawn to its first position by the weight *x*.

As the surface of the stone is not always quite parallel to the bed, a simple contrivance has been adopted, to allow a self-adjustment of the scraper, which is allowed to turn on the centre, and pressed down by a spring acting on each end, but yielding if necessary at either. It is shewn by the dotted lines in fig. 2. The screw *y* presses the scraper lower, or raises it, if required. The scrapers are made of beech wood.

*The Roller.*—The roller for inking the drawing is of the form represented in fig. 7. The length may vary, but it ought to be full four inches in diameter. It is covered with flannel, rolled tightly three or four times round, and nailed at the ends. It is then covered with a stretched calf-skin, fitting quite tight. The seam must be made neatly with the boot-maker's closing stitch. The ends of the leather are gathered with a string, and tied round the projecting ends of the roller. Loose handles, A, A, made of thick leather, are put on these ends when it is used. The leather must be put on the roller with the rough side outwards.

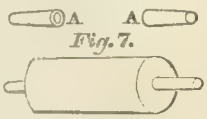


*Fig.* 7.

*Printing Ink.*—The printing ink is composed, as other printing inks are, of oil, varnish, and very fine lamp-black, well mixed together. To prepare the varnish, a saucepan is about half filled with pure linseed oil, and heated over a fire till it ignites from the flame of a piece of burning paper. It should then be allowed to burn till it is reduced to the degree required; and if, during the operation, there appears danger of its boiling over, it must be immediately taken off the fire, and the cover, which ought to fit quite close on the saucepan, must be put on to extinguish the flame. This is to prevent accidents; and the operator cannot be sufficiently cautioned against the danger attending the burning of the varnish, which ought never to be performed in a room with a boarded floor, or indeed in any part of a house. Wet sacks are the best things to put out the flame in case of accident.

Several inks must be prepared, differing in the degree of viscidity, or thickness of the varnish from which they are made, and the quantity of black mixed with them. The longer the oil is burned, the thicker the varnish becomes. The thinnest varnish is burned till it has lost nearly one-fourth of its volume; the next, till it is reduced one-third; the thickest, till it is reduced one-half.

These directions are to be considered as very general ones; and the state of the varnish is best judged of during the burning, by taking out some with a spoon, and letting a drop fall on a cold earthenware plate, and trying its degree of viscidity with the finger. The thinnest sort should be like common honey, the other should draw out in strings, which will be longer as the varnish is thicker. The thickest will draw out in strings two or three feet long. It is quite essential to have the oil pure, and the saucepan perfectly clean, and to keep the varnish in clean close jars in a cool place. It is best not to make the varnish long before it is wanted; for if any decomposition takes place in it, the drawing will be spoiled by the printing ink.

The black is mixed with the varnish on a grinding stone with a muller, in small successive quantities, care being taken that the first portion of black is equally mixed with the varnish before a second is added. In the thickest inks this requires considerable labour. By mixing the varnishes together, any degree of stiffness of the ink may be obtained; and by putting more or less black, its thickness is regulated.

The printer must always have by him several small pots, each containing a different printing ink, to be used as occasion requires. A small quantity, not more than the size of a hazel nut, should be used at a time, for it is desirable to charge the roller with as small a quantity as possible. It must be worked well on the colour table with the roller in all directions, that it may be equally distributed all over the roller. Ink drawings are generally printed with a stiffer ink than chalk drawings.

*Preparation of the Stone for Printing.*—The drawing being finished on the stone as before described, is sent to the lithographic printer, on whose knowledge of his art the success of the impressions entirely depends. The first process is to etch the drawing, as it is called. This is done by placing the stone obliquely on one edge over a trough, and pouring over it very dilute nitric acid. It is poured on the upper part of the stone, and runs down all over the surface. The stone is then turned, and placed on the opposite edge, and the etching water, being collected from the trough, is again poured over it in the same manner. The degree of strength, which is little more than one per cent. of acid, should be such as to produce a very slight effervescence; after the etching water has lain on the stone for a second or two, its strength must vary according to the heat of the atmosphere, and the degree of fineness of the drawing. It is desirable to pass the etching water two or three times over the darkest parts of the drawing, as they require more etching than the lighter tints. Some stones also, and different chalks, require different degrees of strength of the acid, and experience alone can guide the lithographer in his practice on this point. Chalk drawings require weaker acid than the ink.

The stone is now carefully washed, by pouring clean rain water over it, and afterwards with gum water: and, when not too wet, the roller, charged with printing ink, is rolled over it in both directions—sideways, and from top to bottom—till the drawing takes the ink. It is then well covered over with a solution of gum-arabic in water, of about the consistency of oil. This is allowed to dry, and preserves the drawing from any alteration, as the lines cannot spread, in consequence of the pores of the stone being filled with the gum. After the etching it is desirable to leave the stone for a day, and best not to leave it more than a week before it is printed from. In some establishments a few proofs are taken immediately after the drawing is etched, but it is better not to do so.

The operation of the etching requires great nicety, and must be done quickly. If the drawing is etched too strongly, the fine tints disappear; if too weak, the printing ink mixes with the darker parts, and the drawing runs into blots. A soft stone requires weaker acid than a hard one, if they are equally pure in quality. The differences in the composition of the stone also require differences in the strength of the etching water, so that no strict rules can be given. The effect of the etching is, first, to take away the alkali mixed with the drawing chalk or ink, which would make the drawing liable to be affected by the water; and, secondly, to make the stone refuse more decidedly to take any grease. The gum assists in this latter purpose, and is quite essential to the perfect preparation of the surface of the stone.

*Printing.*—When the intention is to print from the stone, it is placed upon the platten or bed of the press, and a proper sized scraper for the printing is adjusted to the surface of the stone. Rain water is then sprinkled over the gum on the stone, which being dissolved gradually, and a wet sponge passed lightly over it all, the printer works the ink which is on the colour table placed beside him, with the roller, in all directions, until it is equally and thinly spread all over the roller. The roller is then passed over the whole stone, care being taken that the whole drawing receives a due portion of the ink, and this must be done by giving the roller an equal motion and pressure, which will of course require to be increased, if it is perceived that the drawing does not receive the ink readily. When the drawing is first used, it will not receive the ink so readily as it will afterwards do; and it is frequently necessary to wet the stone, and roll it several times, before it will take the ink easily. When the drawing once takes the ink readily, care must be taken not to wet the stone too much. Indeed, the less dampness now the better, provided there is sufficient to prevent the stone from taking the ink where there is no drawing. After the drawing is thus rolled in, the sheet of paper is placed on the stone, and the impression taken in the manner described in the account of the Press. When, after the impression, the paper is taken up, the stone appears dry, the moisture having been imbibed by the paper; it must, therefore, be wetted with a sponge, and again rolled in with ink, the roller having been well worked on the colour-table before being applied.

During the printing, some gum must always remain on the stone, although it will not be visible, otherwise the ink will be received on the stone as well as on the drawing, and the drawing spoiled. So that if by too much wetting, or by rubbing too hard with the sponge, the gum is entirely removed, some fresh gum water must be laid on. If the stone has in the first instance been laid by with too small a quantity of gum, and the ink stains the stone on being first applied to it, gum-water must be used to damp the stone, instead of pure water. Sometimes, however, this may arise from the printing ink being too thin, as will afterwards appear. If some spots on the stone take the printing ink, notwithstanding the above precautions, some strong acid must be applied to them with a brush, and, after this is washed off, a little gum-water is dropped on the place. A steel point is here frequently necessary to take off the spots of ink.

The edges of the stone are very apt to soil, and generally require to be washed with an old sponge or rag after the rolling in. They must also frequently have an application of acid and gum, and sometimes must be rubbed with pumice stone. If an ink is too thin, and formed of a varnish not sufficiently burned, it will soil the stone, notwithstanding the proper precautions are taken of wetting the stone, and preparing it properly with acid and gum; and if on the other hand the ink is too thick, it will tear the lighter tints of the chalk from the stone, and thus destroy the drawing. The consideration of these circumstances leads at once to the

*Principles of the Printing.*—These accidents arise at the extreme points of the scale at which the printing inks can be used, for it is evident that the only inks which can be employed are those which are between these points; that is, thicker than that which soils the stone, and at the same time thinner than that which takes up the drawing. Lithographers are sometimes unable to print in very hot weather, the reason of which may be deduced from the above. Any increase of temperature will diminish the consistency of the printing ink; the stone will therefore soil with an ink which could be safely used at a lower temperature; hence a stiffer ink must be used. Now, if the temperature should increase so much that the stone will soil with any ink at all less thick than that which will take up the drawing, it is evident that the printing must cease till a cooler temperature can be obtained; for as the drawing chalk is affected equally with the printing ink, the same ink will tear up the drawing at the different degrees of temperature. This, though it sometimes occurs, is a rare case; but it shews that it is desirable to draw with a chalk or ink of less fatness in summer than in winter; and also, that if the printing room is in winter artificially heated, pains should be taken to regulate the heat as equally as possible.

*Other Difficulties in Printing, not referable to the above general principle.*—If the pressure of the scraper is too weak, the ink will not be given off to the paper in the impression, although the drawing has been properly charged with it. Defects will also appear from the scraper being notched, or not correctly adjusted, or from any unevenness in the leather or paper.

After printing a considerable number of impressions, it sometimes happens that the drawing takes the ink in dark spots in different parts. This arises from the printing ink becoming too strongly united with the chalk or ink of the drawing, and, if the printing is continued, the drawing will be spoiled. The reason of this is easily ascertained. The printing ink readily unites with the drawing, and, being of a thinner consistency, it will, by repeated applications, accumulate on the lines of the drawing, soften them, and make them spread. In this case it is necessary to stop the printing, and let the stone rest for a day or two, for the drawing to recover its proper degree of hardness. If the drawing should run smutty from any of the causes before enumerated, the following

*Mixture for Cleaning the Drawing while Printing* must be used. Take equal parts of water, spirits of turpentine, and oil of olives, and shake them well together in a glass vial, until the mixture froths; wet the stone, and throw this froth upon it, and rub it gently with a soft sponge. The printing ink will be dissolved, and the whole drawing also will disappear, though, on a close examination, it can be distinguished in faint white lines. On rolling it again with printing ink, the drawing will gradually reappear as clear as at first.

*Bleached Paper unfit for Lithographic Printing.*—Accidents sometimes occur in the printing from the qualities of the paper. If the paper have been made from rags which have been bleached with oxymuriatic acid, the drawing will be incurably spoiled after thirty impressions. Chinese paper has sometimes a strong taste of alum; this is so fatal as sometimes to spoil the drawing after the first impression. When the stone is to be laid by after printing, in order that it may be used again at a future period, the drawing must be rolled in with a

*Preserving Ink,*—as the printing inks would, when dry, become so hard, that the drawing would not take fresh printing ink freely. The following is the composition of the preserving ink. Two parts of thick varnish of linseed oil, four parts of tallow; one part of Venetian turpentine, and one part of wax. These must be melted together, then four parts of lamp black, very carefully and gradually mixed with it, and it must be preserved for use in a close tin box. Very good effects are produced in lithographic prints, by

*Printing from two or more Stones*—with different coloured inks. This is managed by preparing a composition of two parts of wax, one of soap, and a little vermilion. Melt them in a saucepan, and cast them into sticks. This must be rubbed up with a little water, to the thickness of cream, and applied to the surface of a polished stone. An impression is taken in the common way from a drawing, and applied to a stone, prepared in this manner, and passed through the press, taking care to mark, by means of this impression, two points in the margin corresponding on each of the stones. The artist having thus, on the second stone, an impression from the first drawing to guide him, scrapes away the parts which he wishes to remain white in the finished impression. The stone must now be etched with acid stronger than the common etching water, having one part of acid to twenty of water. The whole is then washed off with turpentine. This plan is generally used to print a middle tint from the second stone. The black impression being given from the first stone, a flat transparent brownish tint is given from the second, and the white lights are where the paper is left untouched. The dots are necessary to regulate the placing of the paper on the corresponding parts of the two stones. The paper for lithographic printing should not be so damp as for copperplate printing.

LITHOMARGE, in Mineralogy, is a species of the clay genus, and divided, by Werner and others, into two subspecies, *viz.* the friable and the indurated.

LITHONTRIPTICS, an epithet for medicines that are supposed to break the stone in the bladder. Though the different stones that are generated in the human bladder require different solvents when out of the body; and though art has not yet afforded a medicine, which, when injected into the bladder, will, without injury thereto, dissolve the stone therein lodged; it cannot thence be concluded, that there are no lithontriptic medicines. It may be here observed, that one solvent affects one subject, but has no effect on another; so a solvent may yet be met with, that will destroy the stone, and not hurt the human body. The water in which the boiled white of an egg dissolves will liquefy myrrh, but may be put into the human eye without causing any uneasiness. Soap ley, taken at first in small doses, in broth that is freed from all its fat, succeeds in most cases which require an alkaline solvent. The patient may begin with twenty drops, and gradually increase the dose as he is able; and by repeating it three times a day for six, eight, or twelve months, the wished-for effects often follow.

LITMUS, or LACMUS, in the Arts, is a blue pigment, formed from archil. It is brought from Holland at a cheap rate: but may be prepared by adding quicklime and putrefied urine, or spirit of wine distilled from lime, to the archil, previously bruised by grinding. The mixture having cooled, and the fluid suffered to evaporate, becomes a mass of the consistence of a paste, which is laid on boards to dry in square lumps. It is only used in miniature paintings, and cannot be well depended on, because the least approach of acid changes it instantly from blue to red. The best litmus is very apt to change and fly.

LITTER, a kind of vehicle borne upon shafts; anciently esteemed the most easy and genteel way of carriage. Du Cange derives the word from the barbarous Latin *lecteria*, "straw or bedding for beasts." Others will rather have it come from *lectus*, "bed," there being ordinarily a quilt and a pillow to a litter, in the same manner as to a bed. Pliny calls the litter the traveller's chamber; it was much in use among the Romans, among whom it was borne by slaves kept for that purpose; as it still continues to be in the East, where it is called a *palanquin.* The Roman *lectica*, made to be borne by four men, was called *tetraphorum;* that borne by six, *hexaphorum;* and that borne by eight, *octaphorum.* The invention of litters, according to Cicero, was owing to the kings of Bithynia: in the time of Tiberius they were become very frequent at Rome, as appears from Seneca; and even slaves themselves were borne in them, though never by more than two persons, whereas men of quality had six or eight.

LITTER, also denotes a parcel of dry straw put on the floor of a horse's stall, for him to lie down and rest upon. When a horse comes tired into a stable, fresh litter has the virtue of making him stale immediately. This is known to be of very great advantage to a horse in a tired state; and when the litter is old and dirty, it never has any such effect upon him. If the owners knew how refreshing it is for a horse to discharge his urine on his return from labour, they would be more careful of giving them all means and occasions of it than they are. This staling after fatigue, prevents those obstructions in the neck of the bladder, or urinary passages, to which horses are too subject.

LITURGY, denotes all the ceremonies in general belonging to divine service. In a more restrained signification, liturgy is used among the Romanists to signify the mass; and among us, the common prayer. All who have written liturgies agree, that, in the primitive days, divine service was exceedingly simple, only clogged with a very few ceremonies, and consisting of but a small number of prayers; but, by degrees, they increased the number of external ceremonies, and added new prayers, to make the office look more awful and venerable to the people. At length things were carried to such a pitch, that a regulation became necessary; and it was found proper to put the service, and the manner of performing it, into writing; and this was what they called a Liturgy.

LIVERY, in matters of dress and equipage, a certain colour and form of dress, by which noblemen and gentlemen choose to distinguish their servants. Liveries are usually taken from fancy, or continued in families by succession. The ancient cavaliers, at their tournaments, distinguished themselves by wearing the liveries of their mistresses: thus people of quality make their domestics wear their livery.

LIVERYMEN OF LONDON, are a number of men chosen from among the freemen of each company. Out of this body the common-council, sheriff, and other superior officers for the government of the city, are elected; and they alone have the privilege of giving their votes for members of parliament, from which the rest of the citizens are excluded.

LIXIVIATION, is the application of water to bodies, for the purpose of dissolving the saline part: by pouring off the liquid after lixiviation, and then evaporating, the salt is obtained.

LOAD, or LODE, in Mining, a word, used especially in the tin mines, for any regular vein or course, whether metallic or not; but most commonly, load means a metallic vein. When the substances forming these loads are reducible to metal, the loads are by the English miners said to be alive; otherwise they are termed dead loads. In Cornwall and Devonshire, the loads chiefly hold their course from eastward to westward, though in other parts of England they frequently run from north to south.

LOADING AND UNLOADING MACHINE, an invention of G. Davis, of Windsor, for removing ponderous substances to or from waggons, &c. with safety and convenience. In the figure given of this portable machine, (see the Plate,) A is the winch turning the bar B, on which are two endless screws, or worms, C C, that work in the toothed wheels D D. These wheels are fixed to the barrels E E, round which the ropes F F coil, wind up, or let out the same occasionally: the ropes pass over the pulleys G G; are brought round; and their ends being furnished with hooks for that purpose, are hitched into staples fixed to the front of the cart, or other carriage. Within these ropes, the load H is placed on a common step-ladder I, that forms an inclined plane, up which, by turning the winch, the ropes are wound upon the barrels; and thus the load is raised into the carriage. K K, the frame, intended to shew the part of the cart, or other carriage, on which the machine is to be occasionally placed. The whole of the barrels and cogged wheels are contained in an iron box L; the sides of which are represented in the plate as taken off, in order that the arrangement of the different parts may be better conceived. The pulleys on the stage (G G) may, in most cases, be affixed to the machine itself; which is adapted to every direction, and will suit carriages of every construction. The model corresponding to the present engraving is made on the scale of about four inches to a foot; and the inventor states, that it will raise upwards of five cwt. He is therefore confident that this machine, when constructed of its intended size, will be capable of loading a ton weight by *one man only*; and that, even upon this enlarged plan, it does not exceed 112lb. in weight. The Society of Arts in 1797 awarded 40 guineas to Mr. Davis for this useful invention.

LOADING OF A GUN, is the act of charging it, or the charge itself.

LOADSMAN, a pilot or person that conducts into or out of harbours.

LOADSTONE, See the article DIPPING NEEDLE.

LOAMS, in Natural History, are defined to be earths composed of dissimilar particles, stiff, dense, hard, and rough to the touch; not easily broken while moist, readily diffusible in water, and composed of sand and a tough viscid clay. Of these loams, some are whitish, and others brown and yellow.

LOANS, in Political Economy, sums of money borrowed from individuals or public bodies, for the service of the state: they are either compulsory, in which case they may be more properly termed requisitions: or voluntary, which is the only mode that can be frequently resorted to with advantage. Loans are sometimes furnished by public companies as a consideration for peculiar privileges: but are much more commonly advanced by individuals on a certain interest being allowed either for a term of years, or until the principal shall be repaid; the capital stock being transferable.

**LOBE**, in Anatomy, any fleshy protuberant part, as the lobes of the lungs, the lobes of the ears, &c.

**LOBELIA**, *Cardinal-flower*, a genus of plants belonging to the syngenesia class, and in the general method ranking under the 29th order, Campanaceæ.

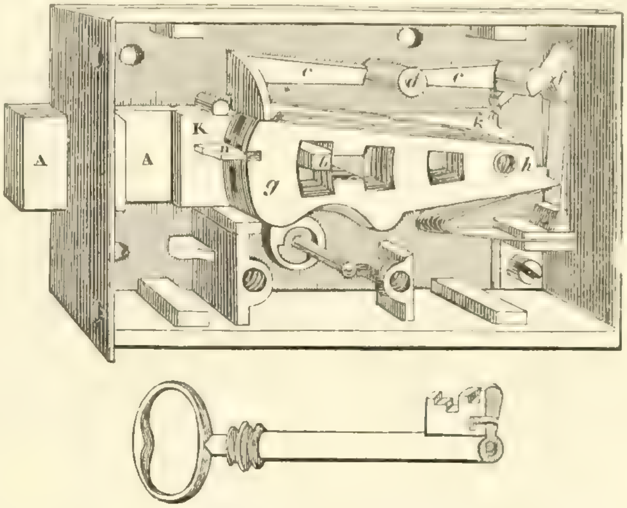
**LOBBY**, in Architecture, is a small hall, or waiting room: it is also an entrance into a principal apartment, where there is a considerable space between that and a portico or vestibule, and the length or dimensions will not allow it to be considered as a vestibule or an anti-room.

**LOCK**, a well known instrument used for fastening doors, chests, &c. generally opened by a key. The lock is reckoned the master piece in smithery; a great deal of art and delicacy being required in contriving and varying the wards, springs, bolts, &c. and adjusting them to the places where they are to be used, and to the several occasions of using them. From the various structure of locks, accommodated to their different intentions, they acquire various names. Those placed on outer doors are called *stock locks;* those on chamber-doors, *spring-locks;* those on trunks, *trunk-locks, padlocks,* &c.—Of these the spring-lock is the most considerable, both for its frequency and the curiosity of its structure. Its principal parts are, the main-plate, the copper-plate, and the pin-hole: to the main-plate belong the key-hole, top-hook, cross-wards, bolt-toe, or bolt-knab, draw-back-spring tumbler, pin of the tumbler, and the staples; to the cover-plate belong the pin, main-ward, cross ward, step-ward, or dap-ward; to the pin hole belong the hook-ward, main cross-ward, shank, the pot or bread bow-ward, and bit.

The principle on which all locks depend is the application of a lever to an interior bolt, by means of a communication from without; so that, by means of the latter, the lever acts upon the bolt, and moves it in such a manner as to secure the lid or door from being opened by any pull or push from without. The security of locks in general therefore depends on the number of impediments we can interpose betwixt the lever (the key) and the bolt which secures the door; and these impediments are well known by the name of *wards*, the number and intricacy of which alone are supposed to distinguish a good lock from a bad one. If these wards, however, do not in an effectual manner preclude the access of all other instruments besides the proper key, it is still possible for a mechanic of equal skill with the lockmaker to open it without the key, and thus to elude the labour of the other. The excellence of locks consists in the security they afford; and as numberless schemes are continually brought forward by designing men, to elude every contrivance of the most ingenious mechanics, the invention of a durable lock, so constructed as to render it impossible for any person to open it without its proper key, has ever been an object of considerable importance.

In the year 1784 the Society for the Encouragement of Arts, &c. conferred their silver medal on Mr. Taylor, of Petworth, for his improvement on the latch or spring-bolts of common locks. This is effected by simply reversing the tumbler, so that its curved side acts against two stubs fixed on the tail of the latch, and thrusts back the latter with ease; whether the knob be turned to the right or to the left, when the lock is opened. Mr. Taylor has also behind the tail of the latch fixed a guide containing a groove, in which runs a small *friction-wheel*, that serves to keep the latch in its direct situation, and at the same time to diminish its friction: the arms of his tumbler are somewhat contracted, in order that the latch or spring-bolt may move with great facility. By this construction, the parts of the tumbler and latch, which are in contact, move in a line, so that they pass over the greatest space, and under the smallest angle; and the lock itself may be constantly used for several years without requiring the application of oil. Various patents have been obtained for the construction of locks, so as to prevent the possibility of picking them: the principal of these is Bramah's.

*Chubb's Patent Detector* Lock.—The following drawing will give our readers a full insight into the peculiarities of Chubb's celebrated Detector Lock. A A *a*, the bolt; *b*, the square pin of the bolt; *c c* the detector moving on the centre *d*; *f* the detector spring; *g* four tumblers moving separately on the centre *h*, shewn lifted by the key to the exact position, for the square pin *b* of the bolt to pass in unlocking. Should one or more of the tumblers be lifted by a pick, or false key, in the least degree beyond their present position, the detector *c c*, being thus overlifted, will, by the angle of the spring *f* pressing on the opposite side of the angle of the detector, force its hook into the notch *a* of the bolt, and be firmly held so, until disengaged by the regulating slide K *k*; in which case, by the introduction of the key, the tumblers are lifted to the *regulating combination*, and admit the stud *n* affixed to the regulating slide, to enter the several grooves in the ends of them; the bevelled end *k* of this slide, by the same movement, pressing against the hook of the detector, disengages it from the notch *a* of the bolt.

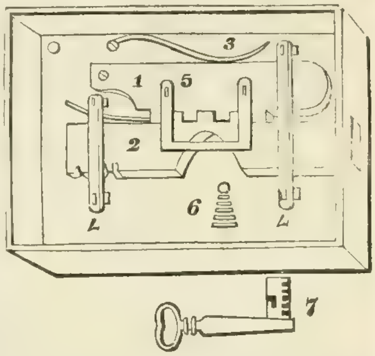


The merits of this lock, as stated by the ingenious inventor, are, that it possesses, in a much higher degree than any other, the four principal requisites of a good lock, *viz.* security, simplicity, strength, and durability. Its security is increased beyond calculation, by an improvement which not only renders it impossible to be picked or opened by any false instruments, but also detects the first attempt to open it, thereby preventing those repeated efforts to which even the best locks hitherto invented are exposed. The instant that one or more of the tumblers are lifted beyond the place where the bolt is at liberty to pass, it overlifts the detector, which then hooks the tail of the bolt, prevents it from passing, and thus gives incalculable additional security, (as well as immediate notice, the first time the true key is put into it to open it, that an attempt has been made to pick it,) and renders all farther attempts useless, it being impossible to discover the first combination, in order to disengage the detector, or the second, in order to remove the bolt. Nothing, in short, but the true key can either release the detector from its grasp on the bolt, or open the lock.

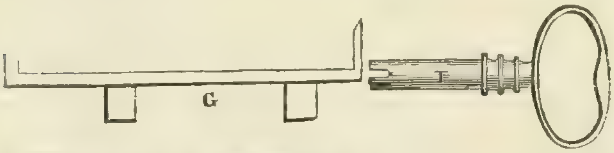
The simplicity of its construction, and strength of its parts, are such, that no false key or other instrument introduced into it for the purpose of opening it, can (without great violence) injure it. The keys are small and portable, particularly those for iron doors.

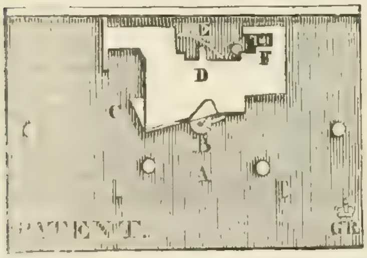
With respect to its durability, it is not liable to be injured by constant use in any length of time; this has been ascertained by an iron-rim lock having been attached to a steam-engine in the dock yard, Portsmouth, (to try the effect of friction,) by which it was locked and unlocked upwards of four hundred and sixty thousand times, without receiving the least injury. The honourable Navy Board lately supplied a considerable number of Chubb's patent detector locks for the use of the Portsmouth dock yard, and being informed that there was a convict on board one of the prison ships at that port, who was notorious for picking locks, (being by profession a lock-maker, and who has, till recently, for several years been chiefly employed in picking and repairing locks in London,) Mr. C. requested the favour of commissioner, the honourable Sir George Grey, to send for this man, that he might exercise his skill in attempting to pick his lock; and the commissioner having been pleased to acquiesce in this request, the man was sent for accordingly, and one of Chubb's patent locks was submitted to his inspection, at the storekeeper's office, in the presence of several of the principal officers; when, after a careful examination, he said, "he thought he could pick or open it with false instruments." He was therefore furnished with files, and all the tools he stated to be necessary to prepare the instruments for his purpose; and was directed to give notice to the storekeeper when he should be ready to make the trial, for the promotion of which a reward of five pounds was promised him if he succeeded. In about three weeks after this time, he sent to say that he was ready; and a time being fixed for the purpose, he commenced his operations in endeavouring to pick one of the locks, in the presence of the principal officers of the dock yard; but he could not succeed.—*Mech. Mag.* 1824.

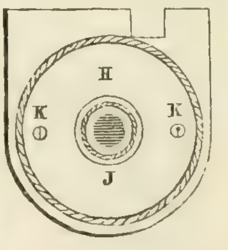
*Bellamy's Improved Common* Lock.—The annexed figures exhibit an ingenious and useful improvement on the common lock, invented by an industrious and hard-working mechanic, of the name of Bellamy, resident in Lambeth. No. 1, is the securer; 2, the bolt; 3, spring for sending the securer down again; 4 4, supporters; 5, the hoister; 6, wards for key; 7, the key, which should have five wards, one after the other, as close as they can be made.



*Ellington's Patent* Lock.—Description of the lock:—A is the brass plate of the lock; B the pin which goes into the pipe of the key, having at the lower part a circular piece of brass, which revolves round it; this has four slits to receive the corresponding parts of the key; C the tumbler; E the spring to keep down the bolt; F the pin to secure the bolt in its place; G the staple (double link); H the cap; I the key; KK the screw holes of the cap; J the bush, or pipe.

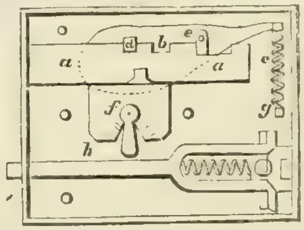






The advantages of this lock will be obvious from the description. Instead of a great heavy key, with a large bit of iron, (called a bit,) being required, as in locks of the kind now in vogue, you have a key so small, that it may be attached to the watch-chain: nor is there any possibility of the bit breaking in the lock, as is sometimes the case, and valuable articles of furniture being thus destroyed or damaged. In the next place, there are no wards to break or bend; the brass circular revolving talent answers the place of the wards, shooting the bolt as it goes round. The slits answer the purpose of keeping out any false pipe, or skeleton-key, which might be introduced. The cap of the lock is made with a large bush, similar to Mr. Bramah's patent, so as to leave no possibility of a picker entering. The price of Mr. Bramah's lock is 3s. 6d.; but the utmost which can, with propriety, be charged for Mr. Ellington's is only 1s. 6d. while it is equally, if not more, secure. Mr. E. warrants, beyond all possibility of being picked, all of his make.

*Fairbank's* Lock, in place of the feather or Scotch spring for forcing out the bolt, is fitted with a spiral or worm spring, by which means the bolts or latches are moved with greater ease than by any other sort of springs; the spiral springs, whether constructed to exert their force by expansion or contraction, are, the inventor thinks, more durable, and less likely to get out of order, than any other description of springs hitherto applied to locks or latches.

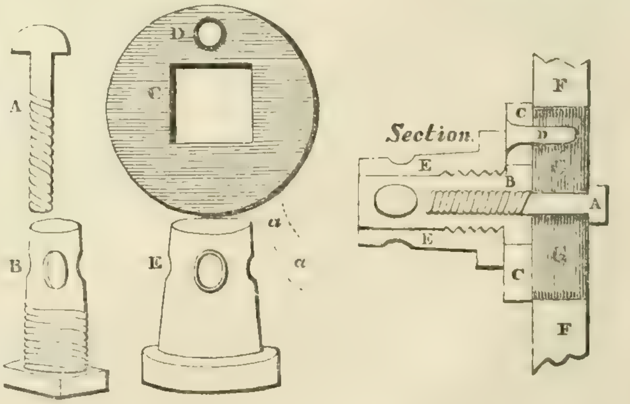


This lock is represented in the figure. *a* is the bolt; *b* the tumbler; *c* the spiral spring acting on the tumbler; *d* a tooth in the tumbler, which falls into one of two notches in the bolt; *e* the pivot stud on which the tumbler moves, square at bottom, in order to guide the bolt; *f* the bridge and wards; *g* a small stud supporting the spiral spring; *h* a catch bolt, which may be forced out by another spiral spring *i*, placed in the fork (or in any other sort of recess); *k* a follow, with two wings acting against the tails of the bolt.

On introducing the key into this lock, and turning it round, it raises the tumbler *b*, and by releasing the tooth *d* from the notch, allows the bolt *a* to be slidden out; after the key has passed the tumbler, the spiral spring acting against the tail of the tumbler, causes the tooth to fall into the second notch, by which the bolt is held fast until the tumbler is again raised by the key. The follow *k* is turned in the common manner, by a pair of knobs, with a spindle, when it draws back the bolt, which is again pushed forward by the spiral spring.—*Mech. Mag.*

Lock *Security*.—The following method of securing locks appeared in one of the numbers of the Mechanical Magazine, but whether it is original or not we have no means of judging.

A, is a piece of round iron, with a cross piece at one end, formed as a screw at the other. B is a stout circular piece of iron or brass, having at one end a square shoulder of half or three-quarters of an inch in thickness; close to this shoulder, on the circular part, a screw is to be formed of three or four turns; and close to the other extremity of this piece, B, a circular hole is made quite through. C is a circular or oval plate of iron or brass, of the same thickness as the square shoulder piece of B, but of greater diameter; in the centre of this piece C, a square hole is to be cut through, to fit easily over the shoulder of piece B. D is a small piece of iron of half an inch projection, fixed in, and just beneath the centre of one of the squares of the aperture in C. E is a hollow iron or brass circular tube, hav-



ing a circular shoulder, which shoulder must be rather larger than the shoulder of B. Within this piece, E, must be formed at the shoulder end, a corresponding screw to the one on B. At the other extremity of E a corresponding circular hole is to be made through, to come in contact with the circular hole in B.

The mode in which this additional lock security will operate is as follows:—The piece A is to screw into the centre of piece B, on the side where the shoulder is, which is to be bored through as far as the circular hole in B, with a corresponding screw of A. Then ascertain the thickness of the door to which you mean to apply this machinery; lengthen or shorten the piece A by means of the screw; introduce your cross-piece, A, into the key-hole, or, as may be, through to the inner side of the door: then turn the cross piece transverse to the key-hole, leaving the shoulder of B as close in contact as possible with the key-hole.

The piece C is then to be slid on the shoulder of B, being made sufficiently large to cover the key-hole. The projecting piece D going into the lower part of the key-hole, keeps the transverse position of A from being displaced. E is then to be screwed over B, tight against the plate C, the shoulder of E being rather larger than that of B, so that the shoulder of E may press against that of C.

The two circular corresponding holes in B and E coming in unison, you pass through the bar of your combination lock, or common padlock, as you please, and your key-hole is then secure from a picklock, or introduction of skeleton or false keys. By making the circular holes longitudinally, you may apply two or more combinations or padlocks, in case you wish to make any room or chest a deposit for joint security. Another great advantage to a door that opens externally, having a key-hole and no lock on it, is that, by having a cross piece, as A, with one side of the cross of a proper length, so as to bear against the inner side of the door-post, your door may be securely fastened.

To travellers, and persons travelling about for pleasure, who too often suffer from the insecurity of locks, this apparatus seems particularly worthy of attention. No injury is done by applying it, and it is of such light weight, as to be portable in the pocket. This invention professes to come from a lieutenant of the royal navy; we should have been happy to have added his name, did we know it.

*Description of an Instrument for Securing Door and other* Locks.—The object of the instrument about to be described, and which is here represented, is to prevent the introduction of a skeleton key, or similar implement, into a lock, for the purpose of opening it. Its parts are as follow: *a a* is a circular plate of stout iron, sufficiently large to cover the key-hole; *b b* is a cylindrical pipe, which passes perpendicularly through a hole in the centre of the plate *a a*, and is strongly fastened to it by means of the projecting shoulder *e e*; *d d* is a round bar, enclosed in the pipe *b b*; *c* is a small nut riveted to the end of *d d*, for the purpose of turning it; *m n* are two small pieces of iron attached transversely to the cylindrical pipe *b b*, and its enclosed bar *d d* respectively. When the instrument is being introduced into the key-hole, these pieces coincide, or rest longitudinally upon each other (as in fig. 1); but when passed through the lock, they are turned at right angles to each other, by the thumb-nut, or bottom already mentioned, and are, in this situation, firmly inserted cross-wise into each other, by means of a small groove, cut in each of them; *n* (fig. 2) is a front view of these pieces when secured in their place; *f* is a cylindrical aperture, part of which is in the wire *a*, and part in the shoulder *e*. To this aperture is accurately fitted the transverse bar of a strong combination lock, so complex as to be totally inaccessible to any person except the possessor of its key. While the bars at *m*, *m*, remain across each other, the instrument cannot be removed out of its place; and hence the security of this lock, for strong boxes, counting-houses, and places of safety.—*Mech. Mag.* 1824.

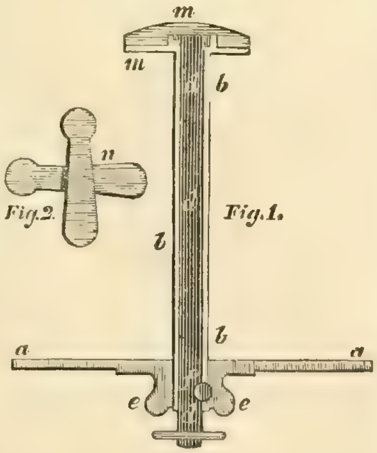


Fig.2.
Fig.1.

*New Double Door Spring.*—The annexed are drawings of a double door spring, invented by Mr. James White, of Laystall-Street, which may be fixed either at top or bottom of the door, and is so contrived that the power of the spring is greatest when the door is shut. It is not liable to get out of repair, and the expense is moderate, not exceeding twenty-two shillings.

In fig. 1, the dotted lines *a a*, shew part of the door shut; *b*, the centre on which the door turns: *c*, an arm carrying a friction roller (*d*, fig. 3); *e e*, two levers on which the spring *f f* acts, and thereby holds the door shut; *g*, a stop, which prevents the levers being pushed farther than to the shut door. When the door is shut, the spring *f* acts with half its power on the arm *c*, at full length, but when the door is open as in fig. 2, it acts with about one-sixth of its power on the arm *c*, in a direction which reduces its effect on the door also about one-sixth, whereby the action on the door, when open, is one-eighteenth of the power which holds it shut; but admitting the strength of the spring to have increased by one-half, there then remains a reduction of power equal to one-twelfth of the original quantity. These numbers, however, depend on the proportion of the levers, and on the part where the spring acts.

Fig. 1.

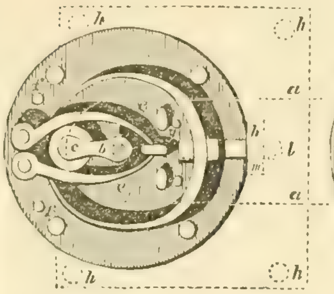


Fig. 2.

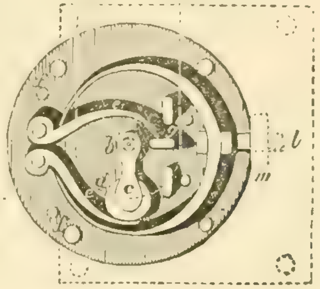
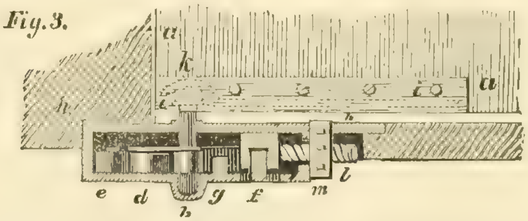


Fig. 3.



In figs. 1, and 2, the upper plate by which it is screwed to the floor, is removed, to shew the parts; its place is shewn by the dotted lines and holes *h h h h*. Fig. 3, a section of the box; *a a*, part of the door shut; *i i*, a brass shoe screwed on the door; the centre *b* is fitted into a square hole, and secured by a screw nut *k*; *l*, a screw which hooks on to the spring *f*, to regulate its power by turning the nut *m*. *Mech. Mag.* 1824.

Lock, or *Weir*, the general names for all those works of wood or stone made to confine or raise the water of a river: the banks also which are made to divert the course of a river are called by these names in some places. But the term Lock is more particularly appropriated to express a kind of canal enclosed between two gates; the upper called by workmen the sluice-gate, and the lower called the flood-gate. These serve in artificial navigations to confine the water, and render the passage of boats easy both in passing up and down the stream.

**LOCKER**, a kind of box or chest made along the side of a ship, to put or stow any thing in.—*Shot* Lockers, strong frames of plank near the pump-well in the hold, in which the shot are put.

**LOG**, a machine used to measure the rate of a ship's velocity through the water. For this purpose, there are several various inventions, but the one most generally used is the following, called the common log. It is a piece of thin board, forming the quadrant of a circle of about six inches radius, and balanced by a small plate of lead nailed on the circular part, so as to swim perpendicular in the water, with the greater part immersed. The log line is fastened to the log by means of two legs, one of which is knotted through a hole at one corner, while the other is attached to a pin fixed in a hole at the other corner, so as to draw out occasionally. The log line being divided into certain spaces, which are in proportion to an equal number of geographical miles, as a half, or quarter minute, is to an hour of time, is wound about a reel.

The whole is employed to measure the ship's head-way in the following manner: the reel being held by one man, and the half-minute glass by another, the mate of the watch fixes the pin, and throws the log over the stern, which, swimming perpendicularly, feels an immediate resistance, and is considered as fixed, the line being slackened over the stern, to prevent the pin coming out. The knots are measured from a mark on the line, at the distance of twelve or fifteen fathoms from the log; the glass is therefore turned at the instant that the mark passes over the stern; and as soon as the sand in the glass has run out, the line is stopped; the water then being on the log dislodges the pin, so that the board now presenting only its edge to the water, is easily drawn aboard. The number of knots and fathoms which had run off at the expiration of the glass, determines the ship's velocity. The half-minute glass and divisions on the line should be frequently measured, to determine any variation in either of them, and to make allowance accordingly.

If the glass runs thirty seconds, the distance between the knots should be 50 feet. When it runs more or less, it should, therefore, be corrected by the following analogy. As 30 is to 50, so is the number of seconds of the glass to the distance between the knots upon the line. As the heat or moisture of the weather has often a considerable effect on the glass, so as to make it run slower or faster, it should be frequently tried by the vibration of a pendulum. As many accidents attend a ship during a day's sailing, such as the variableness of winds, the different quantity of sail carried, &c. it will be necessary to heave the log at every alteration; but if none of these alterations be perceptible, yet it ought to be constantly heaved.

In ships of war and the East Indiamen, it is usual to heave the log once every hour, and in all other vessels once in two hours; and if at any time of the watch the wind has increased or abated in the intervals, so as to affect the ship's velocity, the officer generally makes a suitable allowance for it at the close of the watch.

The inventor of this simple but valuable device is not known, and no mention of it occurs till the year 1607, in an East India voyage published by Purchas. Since that time the term has become quite familiar, both among our own countrymen and foreigners, and there can be no room for apprehension, that a contrivance so useful will ever share the fate of its author.

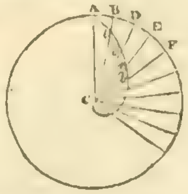
*Log* Board, two boards shutting together like a book, and divided into several columns, containing the hours of the day and night, the direction of the winds, and the course of the ship, with all the material occurences that happen during the twenty-four hours, or from noon to noon, together with the latitude by observation. From this table the officers work the ship's way, and compile their journals. The whole being written with chalk, is rubbed out every day at noon.

*Log*-Book, a book into which the contents of the log-board is daily transcribed at noon, together with every circumstance deserving notice that may happen to the ship, or within her cognizance, either at sea, or in a harbour, &c. The intermediate divisions or watches of a log-book, containing four hours each, are usually signed by the commanding officer thereof, in ships of war or East Indiamen.

Log *Line*, the line which is fastened to the log.

**LOGARITHMS**, (the ratio of numbers,) are the indices of the ratio of numbers to one another, or they are a series of numbers in arithmetical progression, answering to another series of numbers in geometrical progression; or, which conveys a still more simple and unembarrassed idea of these numbers, they are indices of the powers of a certain radix, which, when involved to the power denoted by the index, is equal to the given number; thus, if $r^x = a$, $r^y = b$, $r^z = c$, then is $x$ the logarithm of $a$, $y$ the logarithm of $b$, $z$ the logarithm of $c$, &c. where $r$ is called the radix of the system, and may be assumed any number at pleasure, unity only excepted. These numbers are of the greatest possible use in almost all arithmetical and trigonometrical operations, because by the help of them multiplication is performed by addition, division by subtraction, involution by multiplication, and evolution by division. To multiply two numbers together, we must take the sum of their logarithms; to divide one number by another, we must subtract the logarithm of the divisor from the logarithm of the dividend. To involve a number to any power, we must multiply the logarithm of the number by the index of the power. And to extract the root of a number, we divide the logarithm of the number by the index of the power whose root is to be extracted; but each of these rules require some additional illustration, which may be seen in any table of logarithms; but before we proceed any farther, let us attend to the history of this brilliant discovery. These properties of the indices of numbers were taken notice of by Stifelius, and even by Archimedes in his work on the numbering of the sands; but it is to Baron Napier, of Merchiston, in Scotland, that we are indebted for the happy idea of applying such numbers to the purposes of arithmetical and trigonometrical calculation, which first appeared in his "Mirisici Logarithmorum Canonis Descriptio," published at Edinburgh in 1614. But of all those who assisted in the construction of logarithmic tables, Briggs is the most conspicuous; it was he who first suggested our present system, the advantages of which are incalculably greater than those first constructed by Napier, at the same time that he laboured more than any one in the construction of them. In the present state of analysis, many comparatively short methods may be employed for this purpose, that were unknown to the early writers, and for want of which the labour attending the first computation was exceedingly great, notwithstanding they had certain means of abridging the operation in particular cases; a minute and interesting account of which, with an explanation of their several modifications, is given by Dr. Hutton in the introduction to his Mathematical Tables, to which work the reader is referred for every information on this subject. The publications relating to logarithms are so numerous, that we can only find room to mention a small portion of them; but as it is useful to know which are reputed the best authors, and particularly the best editions of the same authors, we shall subjoin the following list, which may be considered as containing the most respectable and accurate works of this kind: The first Canon of Logarithms for natural Numbers, from 1 to 20000, and from 90000 to 101000, was constructed and published in 1624, by Briggs, with the approbation of the inventor, Lord Napier. Briggs' Logarithms, with their difference to 10 places of figures; as also the logarithmic sines, tangents, &c. by George Miller, London, 1631. Sherwin's Mathematical Tables, published in 8vo. London, 1704, form the most complete collection of any we have yet noticed; containing, besides the logarithms of all numbers from 1 to 101000, the sines, tangents, secants, &c. versed sines, both natural and logarithmic, to every minute of the quadrant. The first edition was printed in 1706, but the third, published in 1742, as revised by Gardiner, is considered as superior to any other. The fifth and last edition, published in 1717, is so incorrect that no dependence can be placed upon it. Dr. Hutton's Mathematical Tables contain the common hyperbolic and logistic logarithms; also sines, tangents, secants, and versed sines, both natural and logarithmic; together with several other tables useful in mathematical calculations; to which is prefixed, a history of the discoveries and writings of the most celebrated authors on this subject. This work was first published in 1785, since which time it has passed through five editions, and is much esteemed for its accuracy. Taylor's Tables of Logarithmic Sines and Tangents, to every second of the quadrant; to which is prefixed, a Table of Logarithms from 1 to 100000, is a very valuable work, and has a useful introduction, composed by the late astronomer royal, Dr. Maskelyne.

**LOGARITHMIC** or **Logistic Spiral**, is a curve having similar properties to the above, but differently constructed; thus, divide the quadrant of a circle into any number of equal parts in the points A, B, D, &c.; and from the radii C A, C B, C D, &c. cut off C A, C *b*, C *d*, &c. continually proportional, then the curve passing through the points A, *b*, *d*, &c. will be the logarithmic spiral. Hence the several areas are as the logarithms of the ordinates; and hence the denomination of the curve.



**LOGIC**, or *the Art of Reasoning*, is intended to guide and assist the intellectual powers of man in the investigation of truth, and in the communication of it to others. This science is not, therefore, a mere explanation of scholastic and barbarous phrases; nor a set of rules to teach the art of disputation; but it traces the progress of the human understanding in the acquisition of knowledge, and thus suggests the best methods of avoiding error, and discovering truth.

The operations of the mind in acquiring and communicating knowledge, are, "Perception," "Judgment," "Reasoning," and "Disposition;" and into these parts logic is divided.

*Perception*, or conception, is the attention which the mind gives to impressions made upon it, and the results of perception are sensations and ideas. Example. We can conceive of a horse, a tree; of motion, time, &c. which will produce corresponding sensations and ideas.

*Judgment*, is the operation of the mind by which we join two or more ideas together by an affirmation or negation. Sentences, called propositions, are the effect of judgment. Example. "This tree is high:" here are two ideas, *viz.* one of a tree, and another of its height: the sentence is complete and affirmative. "That house is not large:" this is a negative proposition. Both are the effect of judgment.

In *Reasoning*, we determine the relation between two ideas, by comparing them with a third idea, called the middle term. Example. If we affirm, that "God will make a difference between the evil and good," it is the result of reasoning, by which we suppose, that "A just being will make a difference between the good and evil;"—and that "God is a just being."

The result of reasoning is an inference; and the expression of an act of reasoning is called a syllogism. Example:

A Creator is to be worshipped.
God is a Creator;
Therefore, God is to be worshipped.

Here is a syllogism; and the inference is, that "God is to be worshipped."

*Disposition* is the proper arranging of our ideas upon any subject, so as to assist our own and others' conception and memory. The result of disposition is method.

*Of Ideas.* There are two modes of perception, *viz. sensation* and *reflection.* Sensation is the perception of an object by the organs of sense, which are five, *seeing*, *hearing*, *tasting*, *smelling*, and *touching.* By sight we acquire ideas of light and darkness, and colours; by hearing, of sounds, &c. Reflection is the perception, intellectually, of the operations of our minds, and by this we gain sensations and ideas.

Illustration: Reflection presupposes sensation, as its impressions are only the effect of the various powers of the understanding, employed about perceptions already in the mind.

A *Sensation* is the impression made upon the mind by an object actually present; an *idea* is a revived impression in the absence of the object. Illustration: The grand source and inlet of knowledge is sensation, which comprehends all the notices conveyed into the mind by impulses made upon the organs of sense.

Ideas are either simple or complex.

*Simple Ideas* are those that exist in the mind under one uniform appearance, without variety or composition, as a colour, or sound.

*Complex Ideas* are those that may be divided into two or more simple ideas, as a square, a triangle, &c.

Simple ideas enter the mind only by inlets appropriated to this purpose, and it cannot refuse to receive them.

Simple ideas are incapable of change; but they gradually wear out of the mind, unless revived by the same means by which they were originally acquired. Example: We soon forget the countenance of a man whom we have seen but once.

Simple ideas are capable of combinations in an indefinite variety of forms, and are the materials of all our knowledge.

*Complex Ideas*, or collections of objects, are produced by Composition, Abstraction, and Comparison. By Composition we add or augment, as, a waggon and horses. By Abstraction we select certain properties of an object, and overlook others, as when we contemplate a triangle, a square. And by Comparison, we have ideas of greater and less, &c.

Complex ideas are either representations of objects really existing, or collections made at the pleasure of the mind.

The objects really existing are either substances, or modes.

Substances are beings or things, subsisting by themselves; as steel, brass, &c. Modes are the properties of substances, and dependent upon them for support; as hardness, softness, brightness, extension, &c.

Our ideas of substances extend only to their properties.'

Modes are either *essential* or *accidental:* an essential mode is that which is necessary to its existence, as solidity and roundness are essential to a bowl; an accidental mode is that which is not necessary to the existence of the subject, as roundness is only an accidental mode of a stone; the bowl cannot exist as a bowl without roundness, but a stone may.

*Of Words.* Words are articulate sounds used as the signs of ideas. The connexion between words and ideas is perfectly arbitrary; but, by frequent use, a term becomes so strongly associated with an idea, that it never fails to suggest it. The use of words is to record our own trains of ideas, and to communicate our thoughts to others: our ideas are recorded by being clothed in words, and communicated in writing. We communicate our thoughts to one another by a tacit agreement to annex the same ideas to the same words.

Language may be resolved into nouns and verbs, with their abbreviations.

Nouns express the names of things, and are either substantives, which are the things spoken of, or adjectives, which denote the qualities or circumstances belonging to them.

Verbs express *modes* of existence, either simply, as "to be;" or existence in an active state, as "to run," "to walk," &c.; or existence in a passive state, as "to be elected."

Indeclinable particles are abbreviations of nouns and verbs, invented for the greater expedition of communicating our thoughts; thus *if* signifies *give; and* signifies *add*, being the imperatives of the verbs.

Simple words are the elements of language, as simple ideas are of all knowledge.

*Of Definition.* Definition is an enumeration of the chief simple ideas of which a compound idea consists, in order to ascertain or explain its nature and character.

Definitions are either nominal, of the name, or real, of the thing.

A *nominal* definition is an enumeration of certain marks or characters, sufficient to distinguish the thing defined from any other. Such is the definition of a square, as a figure containing four equal sides, and four right angles.

A definition of *a thing* includes an enumeration of the principal attributes of the thing, in order to explain its nature; thus an isosceles triangle is a figure having the angles at the base equal.

Definitions are either *accurate* or *inaccurate;* the first are strictly definitions, the second only descriptions.

The rules for a good definition are, 1. It should be clear, and more obvious than the thing defined. 2. It should agree to all the species included under the same idea. It must be peculiar to the thing defined. 4. It should be short. 5. Neither the thing defined, nor a mere synonymous name, should make any part of the definition.

*Judgment.* When two ideas are compared, they either concur, as, snow and whiteness, or coincide, as God and Creator; they do not concur, as vice and usefulness; or they do not coincide, as man and eagle. This concurrence and coincidence of ideas, or the want of it, we call *judgment*, which is, in fact a third or intervening idea.

The sources of judgment are consciousness, sense, intuition, and testimony.

*Consciousness* is the mind's perception of its own existence, faculties, and operations. The senses teach us the existence, properties, and powers of external objects; and the foundations of natural knowledge.

*Intuition* is the instant perception of the relation between two ideas, as "the whole is greater than any of its parts, and equal to all its parts."

*Testimony* is the criterion of facts, which do not fall immediately under our own observation. Illustration: The province of testimony is the proof of facts, which having happened in past times, or in distant places, have not fallen under the cognizance of the senses. Testimony must be true when the relater is not himself deceived, and does not intend to impose on others.

A judgment or mental proposition, is that union or separation of the ideas which is the result of the act of judging, and it may exist without any connexion with words.

A proposition is a judgment clothed in words, and it consists of three parts, the subject, the predicate, and copula. Example 1. Virtue is excellent. 2. Gold and silver are the most precious metals. Here *virtue* in the one example, and *gold and silver* in the other, are subjects; the verbs *is* and *are* the copulæ; *excellent* and *most precious metals* the predicates.

The *subject* of a proposition is the idea concerning which something is affirmed or denied; the *predicate* is the idea united to, or separated from the subject; the *copula* is the sign which represents the union or the separation of the subject of the predicate. Illustration: In the proposition, "Wisdom is the principal thing." *Wisdom* is the subject, *is* the copula, and *principal thing* the predicate.

The several parts of a proposition are not always distinctly expressed, but are always understood; thus, "I walk," "he pleads," may be resolved into "I am walking," "he is pleading."

Propositions may be divided into affirmative and negative; the *affirmative* connects the predicate with the subject, as "gold is heavy;" the *negative* separates the predicate from the subject, as "Man is not perfect." Propositions are universal and particular; in an *universal* proposition, the predicate extends to the whole subject, as "*All men* are mortal." "*No man* is truly happy." The signs of an universal proposition are usually the words *all, every, no, none.* In a *particular* proposition, the predicate is limited to a part of the subject, as "*Some* people are good." "*Many* philosophers have been deceived."

The signs of particular propositions are, *some, many, few,* &c.

Propositions are true or false: a *true* proposition unites ideas that agree, and separates those that disagree, as "God is good." "Men are not truly wise." A *false* proposition affirms an agreement between ideas that disagree, and a disagreement between those which agree, as "A good king oppresses his subjects." "Virtue is not the road to solid happiness."

A demonstrable proposition is one that may be proved by a train of reasoning, called demonstration, as "Any two angles of a triangle, taken together, are greater than the third." Illustration: Demonstration is a succession of connected propositions, beginning with self-evident, and advancing to remoter truths: such is the mathematical demonstration, which begins with definitions: from these it advances to axioms, or self-evident propositions; and thence to more remote truths.

Corollaries are inferences deduced from truths already demonstrated.

*Fig.* 1.

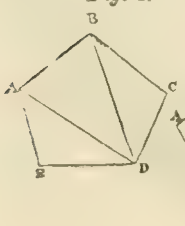
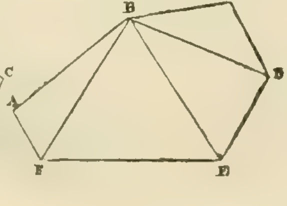


*Fig.* 2.



*Of Reasoning.* Reasoning determines the relation between two or more ideas, by the intervention of another, or third idea. Illustration: If I wish to compare two right lined figures, as A B C D E, and A B C D E F, (see fig. 1 and 2,) with regard to magnitude, I find the thing impossible, on account of their disagreeing forms, one having six sides, and the other only five. I must therefore look for a third idea, in this case, a third figure, with which I may compare both the given figures. All right-lined figures may be divided into triangles, and the areas of all triangles are equal to the base multiplied into half the perpendicular height. Hence I easily compare the two given figures, in respect to magnitude, by the intervention of the third idea, a triangle. See the articles GEOMETRY and MENSURATION.

If the two given ideas agree with the third idea, it is evident that they must agree with each other. If one agrees, and the other disagrees, their mutual disagreement is inferred.

Every act of reasoning consists of three judgments, in two of which the given ideas are compared with the third idea, and in the last they are joined to or separated from each other. Illustration: In the figures above mentioned, the first two judgments are employed in considering into how many triangles each figure may be divided; and in the last judgment, we compare them together with respect to magnitude.

A syllogism is the expression of an act of reasoning, and includes three distinct propositions. The intermediate idea made use of, (as that of a triangle just noticed,) to discover the agreement or disagreement we are in search of, is called the middle term, and the two ideas with which this third is compared, are called extremes.

Example 1. Suppose a comparison to be made between industry and honour, and utility be the third idea, then the syllogism will stand,

Whatever is useful is honourable.
Industry is useful;
Therefore industry is honourable.

Example 2. If the inquiry be, whether a man is bound to cultivate his mind, I say,

Every creature possessed of reason is bound to cultivate his mind.
Man is possessed of reason;
Therefore man is bound to cultivate his mind.

In syllogisms the proposition containing the inference is called the *conclusion;* the two preceding positions are the *premises.* Of the two premises, that is called the *major proposition* in which the greater extreme is compared with the middle term; the *minor proposition* is that in which the less extreme is compared with it.

Example. In the syllogism,

Truth is venerable.
Christianity is truth;
Therefore Christianity is venerable.

"Christianity," "Venerable," and "Truth," are the three terms of the syllogism. "Christianity" and "Venerable" are the extremes, and "Truth" is the middle term. "Venerable" is the *major,* and "Christianity" the *minor term.* "Truth is venerable," "Christianity is truth," are the *premises;* "therefore Christianity is venerable," is the conclusion. "Truth is venerable," is the *major proposition;* "Christianity is truth," is the *minor proposition.*[*]

[Syllogisms may be almost indefinitely varied, and each variety has obtained a distinct name: in this place a very few will be noticed.]

*Hypothetical* syllogisms are those in which the major premise is an hypothetical proposition.

Exam. If there be a God, he ought to be worshipped.
But there is a God;
Therefore he ought to be worshipped.

A *dilemma* is a syllogism in which the consequent of the major is a disjunctive proposition, which is taken away in the minor: or it is an argument by which we endeavour to prove the absurdity or falsehood of some assertion.

Exam. If God did not create the world perfect in its kind, it must have been from want of inclination or power.
But it could not have been from want of inclination, or want of power.
Therefore he created the world perfect in its kind.

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[*] See "A Compendium of Logic, by the Rev. Thomas Belsham, as introductory to his Elements of the Philosophy of the Human Mind," &c.

*Analogy* is an argument from proportionable causes to proportionable effects; and from similarity of circumstances to similarity of consequences.

Ex. All matter with which we are acquainted gravitates;
Therefore gravitation is an universal property of matter.

Illustration: By this mode of argument, we infer that the sun will rise to-morrow, and the next day, and so on. Thus the philosopher believes that the planets are inhabited: and the man of business regards it as certain that a dishonest and avaricious man will take an undue advantage in trade, where the opportunity occurs, as that fire will burn, or a ball will roll down a hill. In other cases the argument cannot be much depended on, as when we intend to draw conclusions concerning the conduct of voluntary agents; this is owing to the difficulty which one person has to enter into the views, objects, and feelings of another, and consequently to foresee in given circumstances, how another man will act.

**LOGWOOD.** The tree which yields it is called by Linnæus, hæmatoxylum campechianum. Logwood is so heavy as to sink in water, hard, compact, of a fine grain, capable of being polished, and scarcely susceptible of decay. Its predominant colour is red, tinged with orange, yellow, and black. It yields its colour both to spirituous and watery menstrua.

**LOLIUM PERENNE**, *Ray* or *Rye-grass*. This has been long in cultivation, and is usually sown with clover under a crop of spring corn. It forms in the succeeding autumn a good stock of herbage, and the summer following it is commonly mown for hay, or the seed saved for market, after which the land is usually ploughed and fallowed, to clear it of weeds, or as a preparation for wheat, by sowing a crop of winter tares or turnips. The seed is about six or eight pecks per acre, and ten pounds of clover mixed, as the land best suits. Although this is a very advantageous culture for such purposes, and when the land is not to remain in constant pasture; yet it is by no means a fit grass for permanent meadow, as it exhausts the soil, and presently goes into a state of decay for want of nourishment, when other plants natural to the soil are apt to overpower it. There are several varieties of this grass: some with the flowers double, others with branched panicles; some that grow very luxuriantly, and others that are little better than annuals; and there is also a variety in cultivation called Pacey's rye-grass, much sought for. But a fine rich soil only will produce a good crop, and the principal difference, after all, is owing more to cultivation or change of soil, than to any real difference in the plant itself.

**LONG, ROGER**, an English astronomical professor, was born in 1679, and received his college education at Cambridge; he became master of Pembroke Hall, and Lowndes's professor of astronomy. He is chiefly known as an author, by a treatise on astronomy, in two volumes; the first of which was published in 1742, and the second in 1764.

**LONGIMETRY**, the measuring of lengths or distances, both accessible and inaccessible. Accessible distances are measured by the application of some measure a certain number of times, as a foot, chain, &c. And inaccessible distances are measured by taking angles, &c. by means of proper instruments, as the *circumferentor*, *quadrant*, *theodolite*, &c. This embraces a great number of cases, according to the situation of the object and observer, a variety of which are given in various parts of this Dictionary.

**LONGITUDE**, in Astronomy, is the angular distance of any star or celestial body from the vernal equinoctial point, that is, if a great circle pass through a star perpendicular to the ecliptic, the arc of the ecliptic intercepted between the intersection of it with this circle, and the vernal equinoctial point, will be the longitude of the star.

LONGITUDE, in Geography and Navigation, is the measure of the angle included between the meridian of any place, the longitude of which is required, and a certain fixed meridian from which the longitude is reckoned; or it is the number of degrees, minutes, &c. intercepted between a certain fixed point of the equator, and the intersection of the meridian of the place with the same circle. This we have illustrated; *see* LATITUDE.

*Degrees* of LONGITUDE vary with the parallels of latitude, being every where as the cosine of the latitude. The following Table shews the length of a degree of longitude, corresponding to every degree of latitude from the equator to the pole, as expressed in English and geographical miles.

TABLE.

| Deg. of Lat. | Deg. Lon. Geogr. Miles. | Deg. Lon. English Miles. | Deg. of Lat. | Deg. Lon. Geogr. Miles. | Deg. Lon. English Miles. | Deg. of Lat. | Deg. Lon. Geogr. Miles. | Deg. Lon. English Miles. |
|---|---|---|---|---|---|---|---|---|
| 0 | 60·00 | 69·20 | 30 | 51·96 | 59·93 | 60 | 30·00 | 24·60 |
| 1 | 59·99 | 69·19 | 31 | 51·43 | 59·32 | 61 | 29·90 | 33·55 |
| 2 | 59·96 | 69·16 | 32 | 50·88 | 58·69 | 62 | 28·17 | 32·49 |
| 3 | 59·92 | 69·11 | 33 | 50·32 | 58·04 | 63 | 27·24 | 31·42 |
| 4 | 59·85 | 69·03 | 34 | 49·74 | 57·37 | 64 | 26·30 | 30·34 |
| 5 | 59·77 | 68·94 | 35 | 49·15 | 56·69 | 65 | 25·36 | 29·25 |
| 6 | 59·67 | 68·82 | 36 | 48·54 | 55·98 | 66 | 24·40 | 28·15 |
| 7 | 59·55 | 68·69 | 37 | 47·92 | 55·27 | 67 | 23·45 | 27·04 |
| 8 | 59·42 | 68·53 | 38 | 47·28 | 54·53 | 68 | 22·48 | 25·92 |
| 9 | 59·26 | 68·35 | 39 | 46·63 | 53·78 | 69 | 21·51 | 24·80 |
| 10 | 59·09 | 68·15 | 40 | 45·96 | 53·10 | 70 | 20·52 | 23·67 |
| 11 | 58·89 | 67·93 | 41 | 45·28 | 52·23 | 71 | 19·53 | 22·53 |
| 12 | 58·69 | 67·69 | 42 | 44·59 | 51·43 | 72 | 18·54 | 21·38 |
| 13 | 58·46 | 67·43 | 43 | 43·88 | 50·61 | 73 | 17·54 | 20·23 |
| 14 | 58·22 | 67·14 | 44 | 43·16 | 49·79 | 74 | 16·54 | 19·07 |
| 15 | 57·95 | 66·84 | 45 | 42·43 | 48·93 | 75 | 15·53 | 17·91 |
| 16 | 57·67 | 66·52 | 46 | 41·68 | 48·07 | 76 | 14·52 | 16·74 |
| 17 | 57·38 | 66·18 | 47 | 40·92 | 47·19 | 77 | 13·50 | 15·57 |
| 18 | 57·06 | 65·81 | 48 | 40·15 | 46·30 | 78 | 12·48 | 14·39 |
| 19 | 56·73 | 65·43 | 49 | 39·36 | 45·40 | 79 | 11·45 | 13·20 |
| 20 | 56·38 | 65·27 | 50 | 38·57 | 44·48 | 80 | 10·42 | 12·02 |
| 21 | 56·01 | 64·60 | 51 | 37·76 | 43·55 | 81 | 9·38 | 10·83 |
| 22 | 55·63 | 64·06 | 52 | 36·94 | 42·60 | 82 | 8·35 | 9·63 |
| 23 | 55·23 | 63·70 | 53 | 36·11 | 41·65 | 83 | 7·31 | 8·43 |
| 24 | 54·81 | 63·22 | 54 | 35·27 | 40·68 | 84 | 6·27 | 7·23 |
| 25 | 54·38 | 62·72 | 55 | 34·41 | 39·69 | 85 | 5·22 | 6·03 |
| 26 | 53·93 | 62·20 | 56 | 33·55 | 38·70 | 86 | 4·18 | 4·83 |
| 27 | 53·46 | 61·66 | 57 | 32·68 | 37·69 | 87 | 3·14 | 3·62 |
| 28 | 52·97 | 61·10 | 58 | 31·79 | 36·67 | 88 | 2·09 | 2·42 |
| 29 | 52·48 | 60·52 | 59 | 30·90 | 35·64 | 89 | 1·05 | 1·24 |

LONGITUDE *Stars*, is a term used to denote those fixed stars which have been selected for the purpose of finding the longitude by lunar observations; as, *α Arietes*, a small star without the zodiac, about 22° to the right of the Pleiades. *Aldebaran*, in the Bull's-eye, a large star, about half way between the Pleiades and the star which forms the western shoulder of Orion. *α Pegasi*, a star about 44° to the right of *α* Arietes, nearly in a line with this latter star and the Pleiades. *Pollux*, to the northward of Aldebaran, one of the two bright stars in the constellation Gemini. *Regulus*, about 38° SE of Pollux, the southernmost of four bright stars to the N. E. of Aldebaran. *Spica Virginis*, a white sparkling star, about 54° S. E. of Regulus. *Antares*, lying to the right hand of Regulus, and about 45° from Spica Virginis. *Formahault*, lying about 45° to the south of *α* Pegasi. *α Aquila*, a star about 47° to the westward of *α* Pegasi.

LONGITUDE *by Time Keeper*, is estimated by the difference between the time at the place, and the time indicated by one of those improved watches, called time keepers.

**LOOF**, the after part of a ship's bow, or that where the planks begin to be incurvated as they approach the stem. Hence the guns which lie here are called *Loof Pieces*.

**LOOK-OUT**, a watchful attention to some important object or event, which is expected to arise from the present situation of a ship; there is always a look-out kept on a ship's forecastle at sea, to watch for any dangerous object lying near her track, or for any strange sail heaving in sight, &c. The officer of the watch accordingly calls frequently from the quarter deck, to the person appointed for this service, "look out afore there."

**LOOMING**, an indistinct appearance of any distant object, as the sea-coast, ships, mountains: "that ship looms large," "the land looms high, &c.

**LOOMS**, Power. The number of power looms in the manufacturing district which surrounds Manchester has been, after careful inquiry, stated to be 30,000.

| | |
|---|---|
| The quantity of cotton converted into yarn in Great Britain and Ireland in one year is about | 160,000,000 lbs. |
| The loss in spinning may be estimated at 1½ on per lb. | 15,000,000 lbs. |
| Quantity of yarn produced | 145,000,000 lbs. |
| Amount, supposing 1s. 8d. to be the average price per. lb. | £10,875,000. |

If every person employed in spinning produces 900 lb. per annum, the number of persons employed is 161,111. The number of spindles employed, supposing each to produce 15 lb. weight per annum, is 9,666,666. The capital invested in buildings and machinery cannot be less than £10,000,000. It is calculated that the rental of Manchester, including Salford, Chorlton, Rew, &c. which form part of the same town, will be increased at least £15,000 this year (1825) by new buildings. The increase is chiefly in cottage property, under £12 a year rent.

*Goodman's Improved Silk Loom.*—The improvements of this machine apply to that description of loom that usually weave narrow articles, as tapes and ribbons, (commonly called Dutch engine looms,) and consist principally in a novel arrangement of the shuttles and slays in the battens. The general appearance of the loom, with its improvements, is shewn in the plate, fig. 1, which is an end view of the machine, exhibiting the disposition of the warps for two sets of shuttles. Fig. 2. shews a part of the front of the batten; and fig. 3, the back of the same; by which the situation of the shuttles, and manner of fixing the slays will be seen, and also the construction of the driver. The front of the batten, fig. 2, is formed by three planks, one of which is fixed to the top-rail by a series of slay screws: the bottom plank is secured to the lower rail in a similar manner; and the middle plank is fastened to the slay rail by a series of screws or pins, as seen in the back view, fig. 3. These screws must have shoulders to leave an open space between the back of the plank and the slay rail, for the action of the drivers.

The shuttles made in the ordinary construction, are introduced in the races between the planks, and the horizontal action of the drivers impels them to and fro through the warp, in the usual manner. The driver in the ordinary engine loom is formed like a ladder, but in this improved loom it is made with teeth extending from the top and bottom rails of its frame, shewn by dots; and these teeth may, if it should be thought desirable, be united together for the purpose of giving them stability, by diagonal pieces crossing the middle of the batten.

For the general operation of the loom, see the Plate of *Looms: b b*, fig. 1, are the rollers, upon which the material is wound, to form two warps; from thence the threads proceed (as shewn by arrows in the figure) in the usual way, up and down over the weighted pulleys, to the back slays *b*, then under the warp-rollers *c* to the leashes *d*, which are looped to arrange with each set of warps, and through which each distinct warp passes to its respective slay. The raising and depressing of the treadles *e*, worked by the feet of the weaver, cause the leashes alternately to move up or down, by which the warp threads are opened; the batten *f* is then pushed back, and the shuttles passed through the open space between the threads. The shifting of the treadles and leashes now cause the intervention of the threads to be made fast, which are beaten up firm, by bringing the batten *f* forward. The continued action of the loom in this manner, and the passing of the shuttles to and fro, produces that intervention of the waft and weft which is the ordinary operation of weaving.

The work thus woven, is drawn off through small apertures in the breast piece *g*, and thence proceeds to the work roller *h*, over which it passes up the back castle *i*, where it is distended by the weighted bags and pulleys; from thence it is carried over the top castle *k*, and through holes in the work castle *l*, where it is made fast by wedges, to prevent it from running back, and as the length of the work accumulates, it is wound round the bobbins *m*.

Although we have described the whole construction and operation of this improved engine loom, the invention claimed by the patentee consists merely "in the new arrangement of the shuttles and the slays, as connected with the batten and the knitting of the leashes, to arrange with the same in the manner above described.

*Description of an improved Loom, by which Purses, Pockets, Sacks, &c. may be woven without requiring a Side-seam, and Work in general may be better executed.*—In this loom, represented by fig. 10, (see Plate of *Looms*,) an oblong frame, A, is laid down horizontally, and secured at the four corners with triangular braces, to keep the frame properly square. Three of these braces, B B B, are visible. Four posts, C C C C, are fixed upright in mortise holes on the above frame. The front posts are supported, both behind and before, with diagonal timbers, D D D D, to keep the breast-roll E from giving way in the least by the heavy stroke of the batten F F, on the quarter or work. The two hinder posts, G G, are held firm by two diagonal supports, H H, within the loom, to bear against the counter-weights I I, and the great weight V, hanging on the work K, and the force of the batten F.

A loom constructed upon this plan, without shorings or supports, will make both strong and slight works firm and good, and its advantages are therefore more important than might be supposed. As journeymen weavers generally live in low-rented houses, the floors and party-walls of the rooms where they weave, are mostly bad and weak; so that the common looms cannot be firmly placed, and the man finds great difficulty in getting his loom into tolerable order; yet if the loom is not set square, and prevented from giving way while used, no work can be made strong and good. The silk chafes and cuts, and the workman is harassed for want of knowing the real cause of the mischief, or not having skill to correct it. These inconveniences are obviated by the bottom frame braced as above mentioned; any ordinary workman can set up this loom well, though it requires a person of considerable judgment to set up an ordinary one. It is a common fault, where shorings or supports are used, to make them too long and slender, in which case, even when they rest against good walls, there is a trembling motion, and if the shake only amount to the hundredth part of an inch, it will take out that stiffness which ought to be in the work. In consequence of the defects thus occasioned in the manufacture, the poor weaver is often turned out of employment, and the master suffers in his property, as he cannot sell the fabric at the price it ought to be worth. A variety of other disadvantages, well known to the trade, attend the use of the loom, not properly squared, shored, and fixed; but it may suffice to refer to one, which is material. A loom set up with stays, must remain always at the same place, although the light may frequently not be suitable to the work, and even when the moving of the machine a few inches would render the light proper. In this point of view, the improved loom is particularly convenient.

*Method of Weaving Sacks, &c. in the Loom above described.*—L, the seat of the loom. M, the treadles, six in number, to raise the harness. N, the counter-meshes to raise the tumblers O, moveable on a pin a little beyond their centre, and which act on the harness P, by raising such parts thereof as they are attached to at their extremities. Q, the work in the loom. R, the reed which strikes the shoot or weft close up. S, the back beam on which the warp or thread is wound. T T, the rods to preserve the crossings of the threads. V, the main weight suspended by a lever U, from a bar W near its centre; the other end of the lever is fastened by a cord to the bottom frame of the loom at X. Y, the rack on the working beam. Z, the catch, to hold the teeth of the rack.

To weave a sack, press down the second treadle on the right hand side, and throw one shoot with the shuttle; next press down the second treadle on the left hand side, and throw another shoot; then proceed in the same manner with the third on the right, and the third on the left, till a sufficient quantity is made; then work the two outside treadles and two shoots. In weaving sacks, it is necessary, between the finishing of one sack and the commencement of another, to pass a thin slip of wood through the threads, in order to form a space between the two sacks.

# Looms.

Genoa Silk Loom

Fig 1

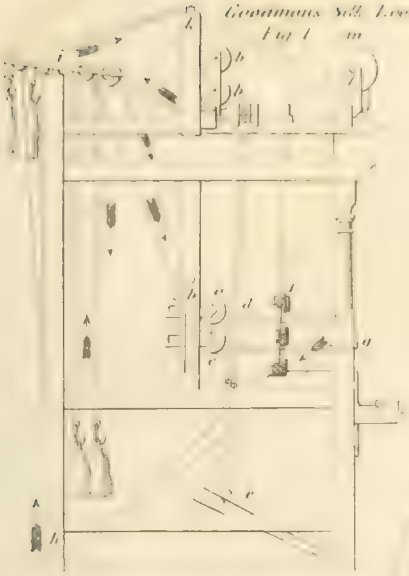


Fig 2

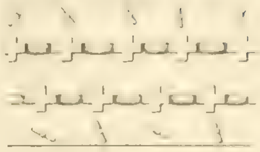
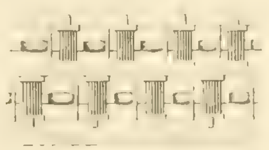


Fig 3



Loom for making Fishing Nets

Fig 1

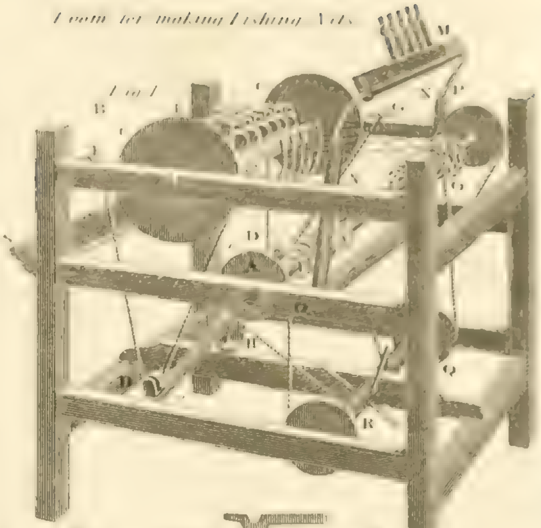
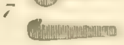


Fig 7



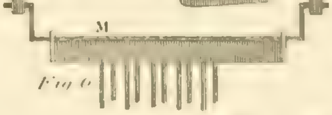


Fig 6

Fig 3

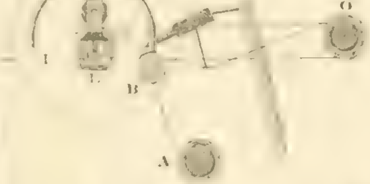


Fig 2

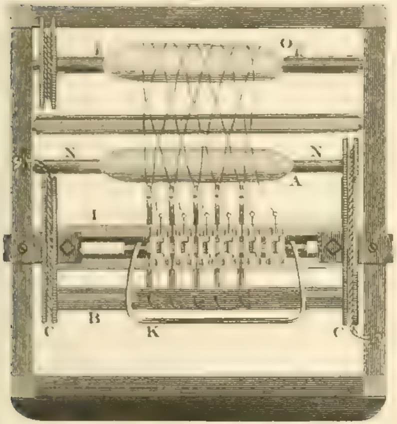


Fig 8

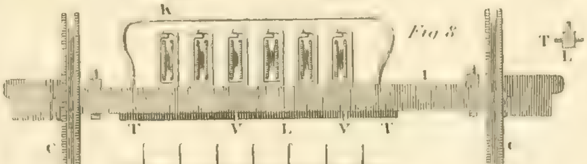


Fig 9

Fig 5

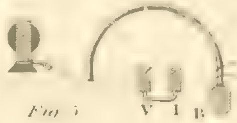


Fig 11

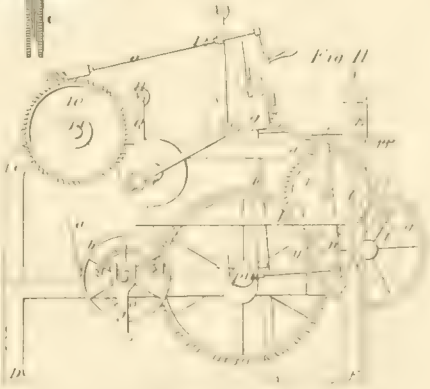
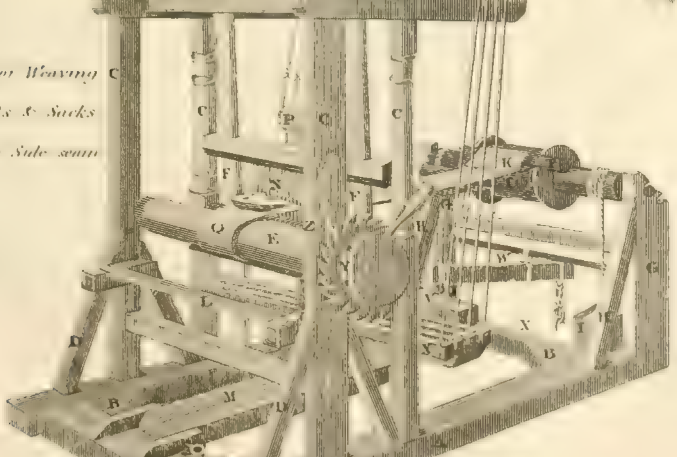


Fig 4

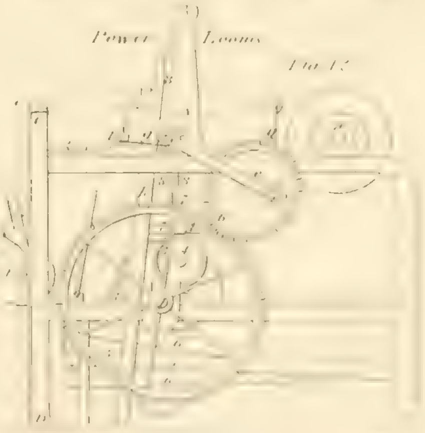
Fig 10

Loom for Weaving Pockets & Sacks without a Side seam



Power Looms

Fig 12



*A Loom for Weaving Fishing-nets.*—A machine for weaving fishing-nets has long been a desideratum; fishermen frequently having their nets broken by dog-fish, and other marine animals, and they experience many difficulties after such accidents, on account of the length of time required by the present mode of netting, in repairing their injured nets, or in making others. A fisherman is sometimes compelled, from these obstructions, to relinquish fishing for a whole season. Any method, therefore, which leads to accelerate the fabrication of nets, without increasing the expense of them, must be beneficial to the community. These considerations swayed the inventor of the loom described below, in devoting much of his attention to this branch of manufacture, until he succeeded in uniting economy and expedition. The loom is represented by figs. 1 to 9, in the Plate.

Fig. 1, is the machine in a state ready to begin working, supported in a wooden frame. A is a beam on which the twines for the net are rolled, in number equal to the knots tied, and from which they pass through circular tubes fixed in a bar B, (shewn by dotted lines through the pulley, but seen better in fig. 2,) which is fixed near the circumference of two equal pulleys, C C, that turn on their axes by means of a cross treadle, with small pulleys at each end, D D, through which passes a band, one end of which is fastened on the frame at E, and the other on the pulley C. At F, the band through the other pulley has one end fastened on the frame at G, and being wound round the farthest pulley C, is fastened on the under side of it, which, by the alternate action of the treadle on its axis H, moves the pulleys C C, and circular tubes, from their situation in fig. 1 to that in fig. 3, and back again.

In the centre of the pulleys C C, is fixed another bar P with a dove-tail groove, where the pirns that contain the twine are supported, (it being necessary to have two threads for every mesh, also one pirn more than there are tubes.) In a groove under the dove-tail is a slider L, moved by a wire K, fixed in each end of it, having pins in it, by which it moves the pirns backwards or forwards over the notches in the bar I, so as to cast a part of the knot: the pulleys C C, and bar B, move round the bar I as an axis, but independent of it; the bar I being fastened through the pulleys to the frame.

M is a moveable bar (centred within two supporters, N N, having two joints) with hooks, both for catching the twine at the end of the circular tubes, and by crossing the hooks to the other side of the points of the tubes, to give the twine a turn for forming the knot; and by raising the points of the hooks, the ends of the tubes enter between them, as shewn in fig. 4, and by the circular motion of the bar B, when the two pulleys C C are turning on its centre by the foot, on the end, No. 1, of the cross treadle; and until the knots so formed are close to the bar B, fig. 3, (it is then what is called a running knot,) a part of which falls into a notch cut below the level of the supporters of the pirns in the bar I; the pirns must then be slidden over the notches that contain the twine, the knot is then cast, and then by the foot on the other end, No. 2, of the cross treadle, the points of the tubes are returned to their former position; remove the knot by disengaging the hooks and the tubes, the knots are then made tight as the wrought part of the net is rolled on the beam O, on one end of which there is a pulley, P, with a band that communicates with the pulley on the end of a short roller Q, in which are fixed four cross bits of wood, that answer the purpose of treadles for the feet, by which it is drawn tight.

R is another short roller, communicating with the roller A, serving to give out the proper quantity of twine for the length of the meshes, or to hold it while the other roller tightens the knot. S is the seat.

Fig. 2, is a plan of the machine; the moveable bar and treadles are left out to prevent confusion.

Fig. 3, is the situation of the running knot when the pirn goes through it.

Fig. 5, is the tube in the same position, shewing the manner in which the knot is twisted round it; and having the pirn and slider L taken out of the bar I, the dotted lines shewing at what height they come together. In the slider L there are two pins, T T, to prevent its rising high enough to touch the string; and in the bar I there are two wires O O, like staples, to support the slider L in its place.

Fig. 6, is the moveable bar M with the hooks.

Fig. 7, shews the hooks at large.

Fig. 8, is the bar I, shewing the notches in which the strings lie to let the pirns pass over them, (when the tubes are brought over as in fig. 3.)

Fig. 9, is the slider L, with the pins that move the pirns.

It appears, by a statement of the inventor, that the nets used in the northern fisheries are of one breadth throughout. He estimates that he can make three courses of one hundred meshes each, in one minute; that such a loom should be about 3½ feet wide, and would cost about fifteen or sixteen pounds.

*A Loom to be worked by Steam or Water.*—A loom having been invented, which may be wrought by steam, water, or any other first mover of machinery, and its practical value having been ascertained by an extensive trial, it will be interesting and useful in this publication, to shew what has been accomplished in this branch of ingenuity, by a record of its properties. A plate of any ordinary size would not be adapted to shew with clearness the principles and construction of this curious machine; but a working model is in the possession of the Society for the Encouragement of Arts, &c. and looms upon this plan possess the following advantages:—1. From 300 to 400 of them may be worked by one water-wheel, or steam-engine, all of which will weave cloth, superior to what is done in the common way. 2. They will go at the rate of 60 shoots in a minute, or two yards of a nine-hundred web in an hour. 3. They will keep regular time in working, stop, and begin again, as quickly as a stop watch. 4. They will keep constantly going, except at the time of shifting two shuttles, when the weft on the pirns is done. 5. In general, no knots need to be tied, and never more than one, in place of two, which are requisite in the common way, where a thread breaks. 6. In case the shuttle stops in the shed, the lay will not come forward, and the loom will instantly stop working. 7. They will weave proportionally slower, or quicker, according to the breadth and quality of the web, which may be the broadest now made. 8. They may be mounted with a harness, or spot headles, to weave any pattern, twilled, striped, &c. 9. There is but one close shed, the same in both breadths, and the strain of the working has no effect on the yarn behind the rods. 10. The bore and temples always keep the same proper distance. 11. There is no time lost in looming, or cutting out the cloth; but it is done while the loom is working, after the first time. 12. The weft is well stretched, and exactly even to the fabric required. 13. Every piece of cloth is measured to a straw's breadth, and marked where to be cut, at any given length. 14. The loom will work backwards, in case of any accident, or of one or more shoots missing. 15. Every thread is as regular on the yarn beam as in the cloth, having no more than two threads in the runner. 16. If a thread should appear too coarse or fine in the web, it can be changed, or any stripe altered at pleasure. 17. They will weave the finest yarn more tenderly, and regularly, than any weaver can do with his hands and feet. 18. When a thread either of warp or weft breaks in it, the loom will instantly stop, without stopping any other loom, and will give warning by the ringing of a bell. 19. A loom of this kind occupies only the same space as a common loom; the expenses of it will be about half more; but this additional expense is more than compensated by the various additional machinery employed for preparing the yarn for the common loom, and which this loom renders entirely unnecessary. 20. The reeling, winding, warping, beaming, looming, combing, dressing, fanning, greasing, drawing bores, shifting headles, rods, and temples, which is nearly one-half of the weaver's work, together with the general waste accompanying them, which is about six per cent. of the value of the yarn; and all which occur in the operations of the common loom, do not happen with this loom, which, by its single motion, without further trouble, performs every operation after the spinning, till the making of the cloth be accomplished; by which, independently of the saving of the waste, the expense incurred for reeling, warping, winding, &c. is saved, amounting to above twenty per cent. of the yarn. 21. The headles, reed, and brushes, will wear longer than usual, from the regularity of their motion. 22. More than one-half of the workmanship will be saved; one weaver and a boy being quite sufficient to manage five looms of coarse work, and three or four in fine work.—The first attempt of the inventor of the above loom, towards constructing such a machine, was made in the year 1789; at which time he entered a caveat for a patent, but relinquished the idea of obtaining one, and afterwards made many improvements upon the original plan. In 1796, a report in its favour was made by the Chamber of Commerce and Manufactures at Glasgow; and in 1798, a loom was actually set at work, in J. Monteith's spinning works, at Pollockshaws, four miles from Glasgow, which answered so well that a building was erected by J. Monteith to hold thirty of the looms, and afterwards another to hold two hundred.

Among the most ingenious inventions, or rather improvements in this useful machine, is the

*Patent Power Loom*, invented by Archibald Buchanan, Esq. of Catrine Cotton-works, one of the partners of the house of James Findlay and Company, whereby a greater quantity of cloth may be woven in a given time without injury to the fabric, than by any application of power for that purpose heretofore employed. This invention consists in the application of two eccentric wheels, A and B, represented in fig. 12, (see the Plate,) to a weaving-loom, impelled by machinery, as represented in figs. 11 and 12; and the application of these wheels to the said loom is particularly exhibited by fig. 12, as explained by the description hereinafter set forth. The inventor claims no part of the said loom, or of its construction, as his invention, or as forming any part of his right of patent, except the application thereto of the said two eccentric wheels.

A reference to the drawings in fig. 11 and 12, and the description hereunto annexed, will enable any person of ordinary mechanical skill, to understand and execute the application and operation of the said two eccentric wheels, either to this loom, or, by slight alterations which will be obviously suggested, to the ordinary weaving looms at present in use by the public. The lay *g*, attached to the rod *h*, vibrating upon its centres below, is connected with the eccentric wheel, B, by means of the crank-rods, at F. This wheel or pinion, B, receives its motions from the wheel A, and the method by which these wheels are constructed, and the manner in which they are applied, are now to be particularly described.

Both wheels, as already mentioned, and as will at once appear by inspecting the drawings, and, more particularly, fig. 12, are what is usually termed eccentric—that is to say, their circumferences, in which the teeth are cut, deviate from the common circular form, in such a ratio as may be required, in order to give the desired motion to the lay. In order to construct such a wheel A, in weaving plain cloth, and which is fixed upon the treadleshaft, *q*, in fig. 11 and 12, the following descriptions and explanations, if carefully attended to, will be sufficient. Its greatest diameter being about 19 inches, and its smallest diameter about 16 inches—its deviation from the circular form amounts to about three inches. This deviation, however, may be increased or diminished, at the discretion of the constructor, and according to the variation of velocity which he wishes to communicate to the reciprocating motion of the lay. To obtain the proper curve of eccentricity, let two eccentric circles be drawn, corresponding with the greatest and smallest diameters. Divide these circles into any convenient number of equal parts; as, for example, 64, and draw radii from the centre to the points of division in the external circle. Divide the space between the circles into the same number of equal parts with the circumference, one of which being set off upon the first radius, two upon the second, and so on progressively, until the whole are set off, points will be obtained, through which a curved line being drawn, the required form of the circumference will be marked off upon each quadrant of the wheel. The highest points, as will appear by the drawings, are at the two extremities of a diameter line, bisecting the external circle and the lowest points, at the extremities of another diameter line, bisecting the internal circles at right angles to the former. Thus, the form obtained bears some resemblance to an ellipse, with its conjugate and transverse diameters. The pinion B must of course be constructed so as to correspond with, and work into, the wheel A. To effect this, it is merely necessary to draw circles as in the former case, corresponding with the greatest and the smallest diameters required. Then set off one-half of the radii drawn upon the wheel A, the pinion being half its diameter, and add, progressively, to each radius of the pinion, as many equal parts as were taken from each corresponding radius of the wheel, and *vice-versa*. The semidiameter of the pinion will thus correspond, in every point with each quadrant of the wheel, and the pinion will revolve twice whilst the wheel performs one revolution, as before stated—thus communicating two accelerated strokes to the lay, for each revolution of the treadle-shaft moving the wheel A. The circumferential forms of both being thus obtained, the teeth are to be cut and rounded off so as to work properly into each other in revolving upon their respective axes. Though the wheel A will thus produce two revolutions of the pinion B, other proportions may be adopted when deemed expedient, and as may suit the motions to be communicated to a greater number of treddles for weaving plain, tweeled, or figured cloths. Those conversant with the art of weaving, will at one perceive, that a varied speed applied to the reciprocating motion of the lay, is of the greatest advantage, and such as will keep the lay as nearly stationary as convenient at the point where the shuttle is thrown across the web; and when the shed, or divided portions of warp, are sufficiently open to allow the shuttle to pass without injury to the warp threads. The lay, in returning, drives up the woof to the fell or verge of the cloth, with a smart stroke, whilst the shed or divided portions of warp are closing upon it, and when the least tension is given by the treadles to the warp threads. Mr. Buchanan ascertained, by experience, that in looms having such wheels, and the other apparatus before described, attached to them, the shuttle may be thrown across a web, 36 inches wide, 130 times per minute, without creating more breakage, in proportion to the quantity woven, than occurs in looms driven at the rate of 80 to 90 crossings of the shuttle per minute.*

*Description of the Drawings.*—The construction of the wheels A B, upon the application of which the patent is claimed, is delineated on the drawing, fig. 12.

Figs. 11 and 12 exhibit the two end views of the loom. In the following description, the same letters of the alphabet, and numerals, denote the same things in all the figures.

C D E F, denote the frame.—*a*, the strap communicating motion to the loom, at *b*; *b*, the fast and loose pulleys; *c*, a pinion fixed on the end of the pulley-spindle, and working into the wheel *d*, of triple the diameter, gives motion to the wiper-shaft, *q*. (See fig. 11.)—*k*, the lever and fork; and *l*, the spring for engaging and disengaging the loom at pleasure. (See fig. 11.) A lever is connected with the protecting pin of the lay, 2, for disengaging the loom, should the shuttle remain in the shed; *m*, a small eccentric wheel, fixed on the end of the wiper-shaft, *q*, (see fig, 11,) and connected with the lever *n*, (see fig. 11,) on the top of which is jointed a circular piece of iron, *o*, (see fig. 11,) which acts on the ratchet wheel *r*, and draws up the cloth as it is woven; and for varying the fabric in thickness, a ratchet-wheel of more or fewer teeth is applied; *p* is a catch bent in the same manner as *o*, which prevents the ratchet wheel, *r*, from returning back. By raising the handle *p p*, these catches are all disengaged. Behind the ratchet-wheel *r*, is fixed a small pinion working into the wheel, which is fixed on the end of the cloth-beam, *t*, (see fig. 11,) and covered with a card fillet for holding the cloth; *x*, is a small roll which receives the cloth from the beam *t*, and round which it is wound, by the motion of the beam *t*; *e*, the crank shaft which receives motion from the wiper-shaft, *q*, by the wheels A and B; *f*, the connecting-bar; *g*, the lay; *h*, the lay-sword. (See fig. 11 and 12.) S, the headle-roll bearer. (See fig. 11 and 12.) Q, the yarn roller bearer. (See fig. 11 and 12.—11, the yarn-roll. (See fig. 11 and 12.) 14, a screw-box. (See fig. 11.); 1, is the protecting catch, for disengaging the loom when the shuttle stops in the shed; this catch is connected with a rod passing along the lay, on which the shuttle springs in the boxes act; when the shuttle fails to enter the box, this catch falls down, and, striking against the pin, 2, the lay is held fast, and the loom instantly disengaged by its connexion with the lever which acts on the handle of the loom *b*. (See fig. 11 and 12.) 3 3, the heddle wipers, which, by acting on the friction pulleys fixed to the treadles, *b b*, alternately elevate and depress the treadles. (See fig. 12.) 7 7, the short marches connecting the heddles, 8 8 8 8, with the treadles, 6 6. (See fig. 12.) 4 4, friction pulleys, fixed to the heddle-wipers, 3 3, acting alternately on the treadles 5 5, to which the picking peg, *q*, for throwing the shuttle, is connected by bolts and screws; 10, is the warp-yarn beam. (See fig. 12.); A B, the eccentric wheels, for giving motion to the lay *q*. (See fig. 12.) *q*, the bearer of the boltfork, *k*, and which extends so as to connect another loom. (See fig. 11;) 14, the friction wheel; its appendages are two plates fastened to the beam-shaft, and upon one of them is glued a piece of leather, which is made perfectly flat by turning; the face of one of the appendage wheels is also turned flat, but this wheel is loose on the spindle; on the outside of it is the screw-box, 14, the outer part of which is made fast to the beam shaft, by a pin passed through it, the inner part of the box is then screwed up against the outer face of the said wheel, which presses the two surfaces together, and any degree of tension can be given to the warp-yarn by more or less screwing of the box, 14. (See fig. 11.) There is a small pinching screw-pin which is screwed into the outer box, the point of which enters a small cavity in the inner part of the box, and prevents it from unscrewing. 17, the long heddle marches connected to the heddles, 8, by cords, and to the short marches, 7 7, by wires. (See fig. 12.) *j*, the bearer of the pulley-shaft. (See fig. 11.)

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* We understand that the patentee of this most important invention has himself driven the shuttle across the web 160 times per minute, without injury to the cloth; a speed which is nearly *double* of that of the looms at present in use.

*Method of Weaving Cloth of extremely Fine Quality.*—This improved mode of weaving consists in adding more thread of the warp within each dent or split of the reed than in the common way; for instance, where in the common mode there are only two threads in the reed, there are upon this plan three or four. The weft or shoot is thrown in the common way with a single thread. When the cloth is woven and taken out of the loom, it has the appearance of being barred or striped, the cane of the reed occasioning that part of the cloth struck with it to look thinner, owing to the threads of the warp being further apart. The cloth is then to be wet in water, and in that state to be repeatedly stretched across by the hands backwards and forwards corner-ways; by this means, the threads which apparently formed the stripe, or close part of the cloth, separate from each other, and become diffused at equal distances. The appearance of stripes being entirely removed, the cloth becomes of inconceivable fineness, and extremely regular in texture. This operation must, in cotton fabrics, be performed before the cloth goes to the bleach-ground. Silk goods, on being taken out of the loom, must be wet and well rubbed, as in the common mode of washing, and then stretched backwards and forwards, in the manner above directed for cotton goods. In silk goods the warp and weft may be both alike; in cotton goods the weft may be softer, but of the same fineness. Fine linen cambrics may be made on this plan, much superior to any hitherto made in France. Though there are three threads within each dent or split of the reed, whilst the cloth is weaving, yet the headles or yealds lift up their threads alternately throughout the whole breadth of the cloth, and there are about 250 shoots in an inch. By this improvement, cotton, linen, and silk goods, can be made much sooner and finer, than by any method yet discovered. The inventor of it made a piece of plain silk cloth, from hand-thrown silk in the gum, that contained the amazing quantity of 65,536 meshes in one square inch. It is impossible to make a reed half so fine as to weave such cloth upon the present principles of weaving; and even if that could be done, no weaver could make use of it: but upon the above plan, which the inventor asserts he can teach in two minutes, as fine cloth may be woven in a twelve hundred reed, as by the old mode in a reed of twenty-four hundred, and with less rather than more trouble.

LOOP Holes, certain small apertures formed in the bulkheads and other parts of a merchant ship, through which the small arms are fired on an enemy who boards her.

LOOPING, in Metallurgy, a word used by the miners of some counties of England, to express the running together of the matter of an ore into a mass, in the roasting or first burning, intended only to calcine it so far as to make it fit for powdering. This accident, which gives the miners some trouble, is generally owing to the continuing of the fire too long in this process.

LOPEZ, or Indian-root, in the Materia Medica.—The plant to which this article belongs is unknown. Neither the woody nor cortical part of the root has any remarkably sensible quality. A slight bitterness is perceptible; and it is recommended, like simarouba, in diarrhœas, even of the colliquative kind, in half-drachm doses four times a day. Little of this root has been brought to Europe; but some of those who have had an opportunity of employing it, speak in very high terms of the effects obtained from it.

LOPHIUS, *Fishing Frog*, *Toad fish*, or *Sea-devil*, a genus of the branchiostegöus order of fishes.

LORANTHUS, a genus of plants belonging to the hexandria class, and in the natural method ranking under the 48th order, Aggregatæ.

LORD, a title of honour given to those who are noble either by birth or creation. In this sense, it amounts to much the same as peer of the realm, or lord of parliament. The title is by courtesy also given to all the sons of dukes and marquises, and to the eldest sons of earls: and it is also a title of honour bestowed on those who are honourable by their employments; as lord advocate, lord chamberlain, lord chancellor, &c.

LORD'S DAY. All persons, not having a reasonable excuse, shall resort to their parish church or chapel (or some congregation of religious worship allowed by the Toleration Act) on every Sunday, on pain of punishment by the censures of the church, and of forfeiting one shilling to the poor. The hundred are not answerable for robberies on the Lord's day. No person on that day shall serve or execute any writ, process, judgment, &c. except in cases of treason, felony, or breach of the peace, and the service thereof shall be void.

LORDS, House of, one of the three estates of parliament, and composed of the lords spiritual and temporal.

LORDASIS, in the medical writings, a name given to a distempered state of the spine, in which it is bent inwards, or towards the anterior parts. It is used in opposition to gibbous, or hump-backed.

LOTION, in medicine and pharmacy, is such washing as concerns beautifying the skin, by clearing it of the deformities made by a preternatural secretion. Almost all the lotions advertised for sale as quack medicines, contain much deleterious matter, such as muriated mercury, and therefore ought never to be had recourse to.

LOTTERIES, games of hazard, in which small sums are advanced for the chance of obtaining a larger value. Lotteries are formed on various plans; but in general they consist of a certain number of tickets, which are drawn at the same time, with a corresponding number of blanks and prizes mixed together, and by which the fate of the tickets is determined. All lotteries, except those established by Act of Parliament, were, in the reign of queen Anne, declared to be public nuisances.

LOUGH, or Loch, the former is the Irish, and the latter the Scotch term for lake. See that article.

LOVE, in a large sense of the word, denotes all those affections of the pleasing kind which objects and incidents raise in us; thus we are said to love not only intelligent agents of morally good dispositions, but also sensual pleasures, riches, and honours. But Love, in its usual and more appropriate signification, may be defined "that affection which, being compounded of animal desire, esteem, and benevolence, becomes the bond of attachment and union between individuals of the different sexes; and makes them feel in the society of each other a species of happiness which they experience no where else."

LOW-BELL, in Birding, a name given to a bell, by means of which they take birds in the night, in open champaign countries, and among stubble in October. The method is, to go out about nine o'clock at night in a still evening, when the air is mild, and the moon does not shine. The low-bell should be of a deep and hollow sound, and of such a size that a man may conveniently carry it in one hand. The person who carries it, is to make it toll all the way he goes, as nearly as may be, in that manner in which the bell on the neck of a sheep tolls as it goes on and feeds. There must be also a box made like a large lantern, about a foot square, and lined with tin, but with one side open. Two or three great lights are to be set in this; and the box is to be fixed to the person's breast, with the open side forwards, so that the light may be cast forward to a great distance. It will spread as it goes out of the box; and will distinctly shew to the person that carries it, whatever there is in the large space of ground over which it extends, and consequently all the birds that roost upon the ground. Two persons must follow him who carries the box and bell, one on each side, so as not to be within the reach of the light to shew themselves. Each of these is to have a hand-net of about three or four feet square, fastened to a long stick or pole; and on whichsoever side any bird is seen at roost, the person who is nearest is to lay his net over it, and take it with as little noise as possible. When the net is over the bird, the person who laid it is not to be in a hurry to take the bird, but must stay till he who carries the light is got beyond it, that the motions may not be discovered. The blaze of the light and the noise of the bell terrify and amaze the birds in such a manner, that they remain still to be taken; but the people who are about the work, must keep the greatest quiet and stillness that may be. Some people are fond of going on this scheme alone. The person then fixes the light box to his breast, and carries the bell in one hand and the net in the other; the net in this case may be somewhat smaller, and the handle shorter. When more than one are out at a time, it is always proper to carry a gun, as it is no uncommon thing to spy a hare when on this expedition.

LOWERING, among distillers, a term used to express the debasing the strength of any spirituous liquor, by mixing water with it. The standard and marketable price of these liquors is fixed in regard to a certain strength in them called proof; this is that strength which makes them, when shaken in a phial or poured from on high into a glass, retain a froth or crown of bubbles for some time. In this state, spirits consist of about half pure or totally inflammable spirit, and half water; and if any foreign or home spirits are to be exposed to sale, and are found to have this proof wanting, scarce any body will buy it till it has been distilled again, and brought to that strength; and if it is above that strength, the proprietor usually adds water to it to bring it down to that standard. There is another kind of lowering among the retailers of spirituous liquors to the vulgar, by reducing it under the standard proof. Whoever has the art of doing this without destroying the bubble proof, which is easily done by means of some addition that gives a greater tenacity to the parts of the spirits, will deceive all that judge by this proof alone. In this case, the best way to judge of liquors is by the eye and tongue, and especially by that instrument called Hydrometer.

LOW Water, the lowest point to which the tide ebbs. See the article Tide.

LOXODROMIC Curve, or Spiral, the path of a ship when her course is directed constantly towards the same point of the compass, thereby cutting all the meridians at the same angle. *See* Rhumb *Line.*

LOZENGE, in Heraldry, a four-cornered figure, resembling a pane of glass in old casements. *See* Heraldry. Though all heralds agree, that single ladies are to place their arms on lozenges, yet they differ as to the origin of this privilege.

Lozenge, is also a form of medicine, made into small bits, to be held or chewed in the mouth till they are melted there: the same with what are otherwise called trochisci "troches."

LOZENGES, among jewellers, are common to brilliant and rose diamonds. In brilliants, they are formed by the meeting of the skill and star facets on the bezil; in the latter, by the meeting of the facets in the horizontal ribs of the crown. *See* Facets.

LUBBER, a contemptuous name given by sailors to those who know not the duty of a seaman.

Lubber's-*Hole*, is the vacant space between the head of a lower mast and the edge of the top; it is so termed from a supposition that a lubber not caring to trust himself up the futtock shrouds, will prefer that way of getting into the top.

LUCIDA, Bright, an appellation used by way of distinction to several stars; as *Lucida Corona*, *Hydræ*, *Lyræ*, &c.

LUCIFER, a name given to the planet *Venus*, when she appears in the morning before sun-rise.

LUFF, the order of the helmsman to put the tiller towards the lee-side of the ship, in order to make the ship sail nearer the direction of the wind, hence

Luff *Round, or Luff a Lee*, is the extreme of this movement by which it is intended to throw the ship's head up in the wind.

Luff *up*, is to bid the steersman keep nearer to the wind.

Luff *into a Harbour*, is to sail into it close by the wind.

A ship is accordingly said to spring her luff when she yields to the effort of the helm by sailing nearer to the wind than she did before.

Luff *Tackle*, a name given to any large tackle that is not destined for a particular place, but may be variously employed as occasion requires. It is generally somewhat larger than the jingle-tackle, although smaller than those which serve to hoist the heavier materials into and out of the vessel, which latter are the main and fore tackles, the stay and quarter tackles, &c.

LUGGER, a vessel carrying three masts with a running bowsprit, upon which she sets lug-sails, and sometimes has top-sails adapted to them.

Lug *Sail*, a quadrilateral sail bent upon a yard which hangs obliquely to the mast at one-third of its length. These are more particularly used in the barca-longas, navigated by the Spaniards in the Mediterranean.

Lug *Sail Boat*, a boat carrying sails of the preceding description.

LUMBAGO, a fixed pain in the small of the back.

LUMBARIS, a name given to the arteries and veins which spread over the loins.

LUMBRICAL, a name given to four muscles of the fingers, and to as many of the toes.

LUMBRICUS, the *Worm*, a genus of animals belonging to the order of vermes intestina.

LUMINARIES, a term employed, by way of eminence, to denote the sun and moon.

LUMINOUS, or Phosphorescent Animals, consist of insects and zoophytes, molluscuous worms, &c. Insects furnish about twelve genera, all the species of which are luminous; among those we may notice the lampyris, or glow-worm, and fire-fly tribes; the fulgora, or lantern-fly; the scolopendra, or centipede; the fausus spœrocenus; the elater noctilucus, and the cancer fulgens. Among the worm-class, the principal are the phloas, or pholas, as it is now generally but erroneously denominated, the pyrosoma, the medusa phosphorea, the nereis nocticula, the pennatula, or sea-pen, and various species of the sepia or cuttle-fish. The atmosphere in some parts of Italy appears occasionally to be on fire, in the evening, from the great quantities of one species of the lampyris that throng together. A single individual of the South America fulgora, fixed upon the top of a cane, or other staff, will afford light enough to read by. The streams of light that issue from the elater noctilucus are so strong in the night, that even the smallest print may be read by their lustre. The acudia or fire-fly is of the beetle kind, and inhabits South America. The natives use them instead of candles, putting from one to three of them under a glass. Madame Meirau says, that at Suriucun, the light of this fly is so great, that she saw sufficiently well to paint and finish one of them in her work on Insects. The largest of the acudia are said to be four inches long, and to shine like a shooting star as they fly. They are thence called *Lantern-bearers.* The pyrosoma, when at rest, emits a pale blue lustre; but when in motion a much stronger light, variegated by all the colours of the rainbow. The phloas secretes a luminous juice, every drop of which illuminates, for a length of time, whatever substance it falls upon, or even touches; and the animal, after death, may be preserved so as to retain its luminous power for at least a twelvemonth. The noctilucent nereis often illuminates, by its numbers, the waters it inhabits, to a very considerable extent; and gives so bright a splendour to the waves, that, like the atmosphere when lighted up by the lampyris italica, they appear as though they were in a full flame. The organ from which the luminous matter is thrown forth, in these different animals, is of a very different character, and placed in very different parts of the body; sometimes in the head, sometimes in the tail, sometimes in the antennæ, sometimes over the surface generally.

**LUMPERS**, labourers employed to load and unload a merchant ship when in harbour.

**LUNAR**, any thing relating to the moon; thus we say, *Lunar Cycle*, *Lunar Month*, *Lunar Year*, &c.

**Lunar** *Distance*, in Navigation, a popular term used to indicate the following rule of finding the distance of the moon from the sun or some fixed star, for the purpose of ascertaining the longitude. Take the difference of the apparent altitudes of the moon and star, or moon and sun, and half the difference of their altitudes; also take half the sum and half the difference of the apparent distance and difference of the apparent altitudes; then to the log. sines of this half sum and half difference, add the log. cos. of the true altitudes (as corrected for semi-diameters, refraction, parallax, and difference, by means of the tables calculated for these purposes) and the complements of the log. cos. of the apparent altitudes, and take half the sum. From this half sum take the log. sines of half the difference of the true altitudes, and find the remainder among the log. tang., which being found, take out the corresponding log. cos. without taking out the arc, which is unnecessary. Lastly, subtract this log. cos. from the log. sine of half the difference of the true altitudes, increased by 10 in the index; and the remainder will be the log. sine of half the true difference.

Thus, for example, let there be proposed the following data, to find the true distances; *viz.*

| | |
|---|---|
| Apparent dist. ☽ and ☉ ......... | 51°28′ 35″ |
| Apparent alt. ☽'s centre........ | 12 30 |
| Apparent alt. ☉'s centre........ | 24 48 |
| True alt...... ☽'s centre........ | 13 20 42 |
| True alt...... ☉'s centre........ | 24 45 57 |
| Apparent altitude of ☉ .......... | 24 48 |
| Apparent altitude of ☽ .......... | 12 30 |
| Different apparent altitudes...... | 12 18 |
| True altitude of ☉ .............. | 24 45 57 |
| True altitude of ☽ .............. | 13 20 42 |
| | 2)11 25 15 |
| ½ difference true altitude ........ | 5 42 37½ |
| Apparent distance ............... | 51 28 35 |
| Different apparent altitude ...... | 12 18 |
| | 2)63 46 35 |
| ½ sum......................... | 31 53 17½ |
| | 2)39 10 35 |
| ½ difference ..................... | 19 35 17½ |

Then by the foregoing rule we have the following computation:

| | | |
|---|---|---|
| Log. sine ........ | 31°53′ 17½″.... | 9·7228488 |
| Log. sine ........ | 19 35 17½ .... | 9·5253755 |
| Co. log. cos....... | 12 30 .... | 0·0104185 |
| Log. cos. ......... | 13 20 42 .... | 9·9881119 |
| Co. log. cos....... | 24 48 .... | 0·0420206 |
| Log. cos.. ....... | 24 45 57 .... | 9·9580990 |
| | | 2)39·2468743 |
| | | 19·6234371 |
| Log. sine ........ | 5 42 37 .... | 8·9978159 |
| Log. tan. of an arch ............ | | 10·6256212 |
| Corresponding log. cosine........ | | 9·3625337 |
| Log. sine ........ | 25 34 54½ .... | 9 6352822 |
| | 2 | |
| True distance .... | 51 9 49 | |

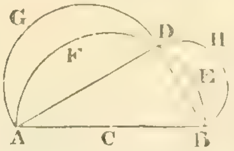
This is the direct method of determining the true distance, independently of any other tables than those of common logarithms, and what are found in the Nautical Almanack; but as this is the most laborious operation connected with the longitude problem, various other rules have been devised, which by the help of certain tables render the operation much more simple and expeditious; but in a work of this kind, we cannot properly enter upon the problem under that point of view, in consequence of our not having the necessary tables to refer to. The most approved of these rules may be seen by consulting Mackay on the Longitude.

**LUNARE OS**, in Anatomy, is the second bone in the first row of the carpus. It has its name from the Latin, *luna*, "the moon," because one of its sides is in form of a crescent.

**LUNARIA**, *Satin-flower*, or *Moonwort*, a genus of plants belonging to the tetradynamia class, and in the natural method ranking under the 39th order, Siliquosæ.

**LUNATION**, the time between one new moon and another; consisting of 29 days, 12 hours, 44 minutes, $3\frac{11}{60}$ seconds,

**LUNE**, **Lunula**, in Geometry, is the space included between the arcs of two unequal circles, forming a sort of crescent or half moon; the area of which may in many cases be as accurately determined as that of any rectilinear figure. The lune was the first curvilinear space of which the quadrature was ascertained, and this is said to have been first effected by Hippocrates of Chios; and the figure still bears his name, being commonly denominated the lune of Hippocrates; the construction of which is as follows:



On the diameter of a semicircle describe a right-angled triangle, of which the angular point will necessarily fall in the circumference. Then on each of the sides A D, D B, describe a semicircle, and the two figures A G F D. D H E B will be lunes, and the area of them will be equal to the area of the right-angled triangle A D B.

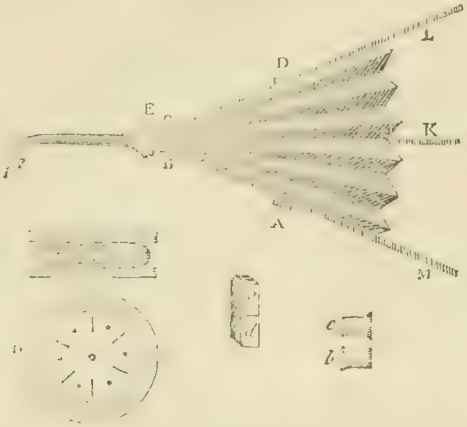
**LUNETTE**, in Fortification, an enveloped counterguard, or elevation of the earth, made beyond the second ditch, opposite to the places of arms, differing from the ravelins only in their situation. Lunettes are usually made in ditches full of water, and serve to the same purpose as faussebrayes, to dispute the passage of the ditch. *See* Fortification.

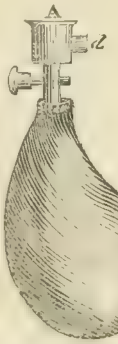
**Lunette**, in the Manege, is a half horse-shoe, or such a shoe as wants the sponge, *i. e.* that part of the branch which runs towards the quarters of the foot.

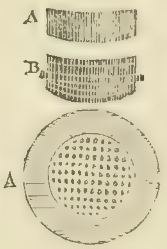
**Lunette**, is also the name of two small pieces of felt, made round and hollow, to clap upon the eyes of a vicious horse, that is apt to bite, and strike with his fore-feet, or that will not suffer his rider to mount him.

**LUNGS**, in Anatomy, a part of the human body serving for respiration. In the *Journal de Medecine* for June, 1789, is a description of an instrument for inflating the lungs, invented by M. Gorcy, physician to the military hospital at Newsbrisach, which appears to be extremely well adapted to the purpose, whilst it may be used with the greatest ease and facility. This instrument, which the inventor styles *apodopic*, that is, "restorer of respiration," consists of a double pair of bellows. B C L M, fig. 1, the two different parts of which have no communication with each other. In the lower side B M is an aperture A, for a valve constructed on the principles of those of M'Nairne's air pump. It consists of a rim of copper, closed at one end by a plate of the same metal, in which plate are seven small holes placed at equal distances. This plate is covered with pieces of silk coated with elastic gum, in which are six transverse incisions, of two or three lines in length. Each incision is so made as to be situated between two of the holes, and at an equal distance from each: see D, fig. 2.

The silk must be made very secure by a thread passing several times round the rim. It is obvious, that a stream of air applied to that side of the plate which is opposite the silk, will pass through the holes, and, lifting up the silk, will escape through the incisions. On the contrary, a stream of air applied to the other side will press the silk upon the plate, and thus close the holes, so that it will be impossible for it to pass through them. This valve opens internally, so as to admit the air from without. At B is another valve, on the same construction, but, opening in a contrary direction, thus permitting the air to escape out of the lower part into the tube E F, but preventing its entrance. At C is another valve, opening internally to admit the air from the tube E F; and at D there is a fourth, opening externally to dicharge the air from the upper part. The flexible tube E F, screwed at the end C B, being introduced into one of the nostrils, whilst the mouth and the other nostril are closed by an assistant, if we separate the two handles L M, which were close together at the introduction of the tube, it is evident that the air in the lungs will rush into the upper part through the valve C, whilst the external air will fill the lower part through the valve A; the two handles being again brought into contact, the atmospheric air will be forced into the lungs through the valve B, and at the same time the air in the upper part will be discharged at the valve D. Thus by the alternate play of the double bellows, the lungs will be alternately filled and emptied as in respiration. In using this instrument, care should be taken not to be too violent; as the more perfectly the natural motion of respiration is imitated, the better. To prevent any substances from without injuring the valves A D, fig. 1, the rim is made with a screw B, fig. 3, in order to receive a cap A A, fig. 3, full of small holes. This screw has also another use. If air, or oxygen gas, be preferred, a bladder, filled with air, fig. 4, may, by means of the screw A, be fastened to the valve A, fig. 1; and, to prevent waste, as this air may serve several times, a flexible tube may be screwed on the valve D, fig. 1, communicating with the bladder by means of the opening *d*, fig. 4: thus it may be employed as often as the operator thinks proper. There is a handle K to the partition in the middle, in order that, if it be at any time necessary to use either of the divisions alone, the other may be confined from acting. *c b*, fig. 5, represent the two valves to be applied at the end of the instrument *c* B, fig. 1; and fig. 6, is a section of the end *c* B, shewing the valves in their proper places. It is proper to add, that the capacity of the instrument should be proportioned to the quantity of air received into the lungs in inspiration, which Dr. Goodwyn has ascertained to be twelve cubical inches, or somewhat more. Each division of the instrument, therefore, should be capable of containing that quantity.







LUPUS, *the Wolf*, one of the old constellations, lies on the East of Centaurus, with which it is bounded on the North by Scorpio, and on the West by Norma Euclidis; or, anciently, by Ara, the altar.

LUSTRAL, an epithet given by the ancients to the water used in their ceremonies to sprinkle and purify the people. From them the Roman church borrowed the holy water.

LUSTRATION, in Antiquity, sacrifices or ceremonies by which the ancients purified their cities, fields, armies, or people defiled by any crime or impurity. Some of these lustrations were public, others private. There were three species or manners of performing lustration, *viz.* by fire and sulphur, by water, and by air; which last was done by fanning and agitating the air round the thing to be purified.

LUTE, or Loting, among chemists, a mixed, tenacious, ductile substance, which grows solid by drying, and being applied to the juncture of vessels, stops them up, so as to prevent the air from geting in or out. Lute is also a musical instrument with strings.—The lute consists of four parts, *viz.* the table, the body or belly, which has nine or ten sides; the neck, which has nine or ten stops or divisions, marked with strings; and the head or cross, where the screws for raising and lowering the strings to a proper pitch of tone are fixed. In the middle of the table there is a rose, or passage for the sound. There is also a bridge that the strings are fastened to, and a piece of ivory between the head and the neck, to which the other extremities of the strings are fitted. In playing, the strings are struck with the right hand, and with the left the stops are pressed. The lutes of Bologna are esteemed the best, on account of the wood, which is said to have an uncommon disposition for producing a sweet sound.

LUTHERN, in Architecture, a kind of window over the cornice, in the roof of a building, standing perpendicularly over the naked part of a wall, and serving to illuminate the upper story. Lutherns are of various forms, as square, semicircular, round, called bull's eye, elliptic arches, &c.

LUXATION, is when any bone is moved out of its place of articulation, so as to impede or destroy its proper office or motion.

LYCIUM, a genus of plants belonging to the pentandria class, and in the natural method ranking under the 28th order, Luridæ.

LYCODONTES, the petrified teeth of the lupus-piscis, or wolf-fish, frequently found fossile. They are of different shapes, but the most common kind rise into a semiorbicular form, and are hollow within, somewhat resembling an acorn cup; this hollow is found sometimes empty, and sometimes filled with the stratum in which it is immersed. Many of them have an outer circle of a different colour from the rest.

LYCOPERDON, a genus of plants belonging to the cryptogamia class.

LYCOPODIUM, or Club Moss, a genus of plants belonging to the cryptogamia class.

LYCOPSIS, a genus of plants belonging to the pentandria class; and in the natural method ranking under the 41st order, Asperifoliæ.

LYCOPUS, a genus of plants belonging to the diandria class; and in the natural method ranking under the 42nd order, Verticillatæ.

LYING-TO, the situation of a ship when she is retarded in her course by arranging the sails in such a manner as to counteract each other with nearly equal effect, and render the ship almost stationary with respect to her head-way: a ship is usually brought-to by laying either her main top-sail or fore-top-sail aback, the helm being put close down to leeward. This is particularly practised in a general engagement, when the hostile fleets are drawn up to battle.

LYMPH, a fine fluid, separated in the body from the mass of blood, and contained in peculiar vessels. It is distinguished into watery and coagulable.

LYNX, The, in Astronomy, is one of the northern constellations, and was composed by Hevelius out of the unformed stars of the ancients.—*Boundaries and Contents:* N. by Ursa Major and Camelopardalis, E. by Leo Minor, S. by Cancer and Gemini, and W. by Auriga and Camelopardalis. There are 44 stars in this constellation, whose right ascension, generally, is 115°, and its declination 45° N. The greater part of it, therefore, does not set to the British isles. None of the stars exceed the 4th magnitude, and their positions may be easily ascertained by reference to the neighbouring constellations. The Lynx is a paratanellon to Gemini and Cancer.

**LYONS**, Israel, a reputable mathematician, and an excellent botanist, was born of Jewish parents in Cambridge, in 1739. He was author of several works, but the only one necessary to mention here is his "Treatise on Fluxions," published in 1758. He was appointed astronomical observer in Captain Phipps's voyage towards the North Pole in 1773; the duties of which office he discharged much to the satisfaction of the Board of Longitude, by whom he was appointed. His death happened about two years after his return from this voyage.

**LYRA**, *the Harp*, one of the northern constellations, which owes its name to the lyre that Apollo gave to Orpheus, and with which he descended into the infernal regions, in search of Euridice. Orpheus, after death, received divine honours, and his lyre became one of the constellations.—*Boundaries and Contents:* This constellation, situated to the S. E. of the head of Draco, occupies the right angle of a triangle formed by Arcturus, Vega, and the Polar Star on the W.; it is bounded by Hercules S. by E., and E. by Cygnus. Lyra is easily known by *Vega*, of the 1st magnitude, which shines with a splendid white lustre; $\beta$, $\gamma$, $\delta$, are also conspicuous stars, of the 2d and 4th magnitudes. Vega, $\alpha$, having 277° 42′ 36″ right ascension, and 38° 37′ 22″ north declination, never sets to the British isles, and it culminates as follows: Merid. Alt. 77° 6′ 22″ N.

| Month. | Culm. | Month. | Culm. | Month. | Culm. |
|---|---|---|---|---|---|
| | ho. mi. | | ho. mi. | | ho. mi. |
| Jan. | 11 54 M. | May | [illegible] 35 M. | Sept. | 7 58 A. |
| Feb. | 9 32 M. | June | 1 51 M. | Oct. | 6 10 A. |
| March | 7 40 M. | July | 11 50 A. | Nov. | 4 15 A. |
| April | 4 15 M. | Aug. | 9 59 A. | Dec. | 2 6 A. |

**LYRE**, a musical instrument of the stringed kind, much used by the ancients.

Concerning the number of strings with which this instrument was furnished, there is great controversy. Some assert it to be only three; and that the sounds of the two remote were acute, and that of the intermediate one, a mean between those two extremes; that Mercury, the inventor, resembled those three chords to as many seasons of the year, which were all that the Greeks reckoned, namely, summer, winter, and spring; assigning the acute to the first, the grave to the second, and the mean to the third.

**LYTHRUM**, *Purple Loosestrife*, a genus of plants belonging to the decandria class; and in the natural method ranking under the 17th order, Calycanthemae. *See* Botany.

# M.

M is the twelfth letter of our alphabet. M is also a numeral letter, and among the ancients was used for a thousand. When a dash is added to the top of it, as $\overline{M}$, it signifies a thousand times a thousand. M, as an abbreviature, stands for Manlius, Marcus, Martius, and Mucius; M. A. signifies magister artium, or master of arts; MS. manuscript; and MSS. manuscripts. M in astronomical tables, and other things of that kind, is used for meridional or southern, and sometimes for meridian or mid-day. M.D. medicinæ doctor, doctor of medicine. M, in medicinal prescription, is frequently used to signify a maniple or handful; and it is sometimes also put at the end of a recipe, for *misce*, "mingle;" or for *mixtura*, "a mixture." Thus, *m. f. julapium*, signifies "mix and make a julep." M, in Law, the brand or stigma of a person convicted of manslaughter, and admitted to the benefit of clergy. It is to be burnt on the brawn of his left thumb.

**MABBY**, a species of wine made from potatoes. Some attempts have recently been made to improve its quality, but without much success. It is said to be in use in Barbadoes.

**MAC**, an Irish word signifying son. It is frequently prefixed to surnames, as *Mac*donald for Donald's son; *Mac*laurin, for the son of Laurin or Laurence.

**MACAM**, in Natural History, the name of an Indian fruit. It is of a round shape, and about the size of our common wild crabs which grow in the hedges. Instead of seeds resembling apples, it has one hard kernel: the taste is unpleasant. The tree is small, and its leaves appear like those of the quince, having somewhat of a yellowish tinge.

**MACARONIC**, or Macaronian, an appellation given to a burlesque kind of poetry, made up of a jumble of words of different languages, and words of the vulgar tongue latinized. The Italians are said to have been the inventors of it. The Germans, French Spaniards, &c. have also had their macaronic poets.

**MACASSAR** Poison, called in natural history, *ippo*, is the gum of a tree that grows in the isle of Celebes, in the Indian Ocean, with which the Malayans anoint their arrows.

**MACE**, the covering of the nutmeg, that lies between the outer coat and the shell. It is an unctuous membrane; first of a light red, and afterwards, when dried as we see it, of a yellowish hue. After being taken from the shell and exposed to the sun, it is dipped in sea water, or moistened with it, and finally so far dried as to allow of its being packed in bales for exportation. Mace is liable to seizure, if packed in bales of less than 300 lbs weight. It possesses all the virtues, without the astringency, of the nutmeg.

**MACERATION**, in Pharmacy, an infusion or soaking ingredients in water, or other fluid, in order to soften them, and draw out their virtues.

**MACHINE**, signifies any thing used to augment or regulate moving forces or powers; or it is any instrument employed to produce motion in order to save either time or force. The word is of Greek origin, and implies *machine, invention, art*; is therefore properly applied to any agent, in which these are combined, whatever may be the strength or solidity of the materials of which it is composed. The term *machine*, is, however, generally restricted to a certain class of agents, which seem to hold a middle place between the most simple tools or instruments, and the more complicated and powerful engines; this distinction, however, has no place in a scientific point of view; all such compound agents being generally classed under the term machines, the simple parts of which they are compounded, being termed Mechanical Powers. Machines are again classed under different denominations, according to the agents by which they are put in motion, the purposes they are intended to effect, or the art in which they are employed; as, *Electric, Hydraulic, Pneumatic, Military, Architectural, &c.* Machines.

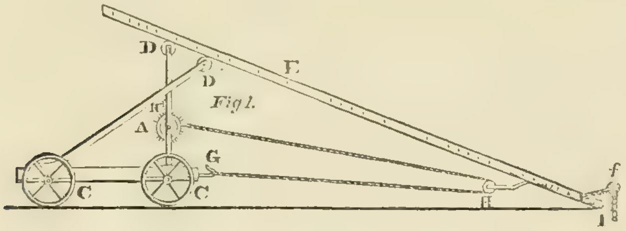
The maximum effect of machines is the greatest effect which can be produced by them. In all machines, working with an uniform motion, there is a certain velocity and a certain load of resistance, that yield the greatest effect, and which are therefore more advantageous than any other. A machine may be so heavily charged, that the motion resulting from the application of any given power will be only sufficient to overcome it, and if any motion ensue, it will be very trifling, and the effect small. Again, if the machine is very lightly loaded, it may give great velocity to the load; but from the smallness of its quantity, the effect may still be very considerable, consequently between these two loads there must be some intermediate one, that will render the effect the greatest possible. And this is equally true in the application of animal strength as in machines, and both have been submitted to strict mathematical investigation, the former being founded on numerous experiments and observations on the best method of applying animal strength, and the measure of it when applied in different directions.

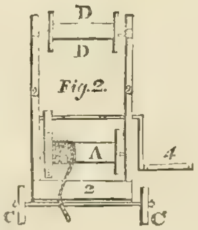
The maximum effect of a machine is produced when the weight or resistance to be overcome is $\frac{4}{9}$ of that which the power when fully exerted is able to balance, or of that resistance which is necessary to reduce the machine to rest; and the velocity of the part of the machine to which the power is applied, should be one-third of the greatest velocity of the power. The moving power P and the resistance R being both given; if the machine be so constructed that the velocity of the point to which the power is applied be to the velocity of the point to which the resistance is applied, as 9 R is to 4 P, the machine will work to the greatest possible advantage.

This is equally true when applied to the strength of animals; that is, a man, horse, or other animal, will do the greatest quantity of work by continual labour, when his strength is opposed to a resistance equal to $\frac{4}{9}$ of his natural strength, and his velocity equal to $\frac{1}{3}$ of his greatest velocity, when not impeded. Now according to the best observations, the force of a man at rest is on an average about 70lbs.; and his great velocity, when not impeded, is about 6 feet per second, taken at a medium. Hence the greatest effect will be produced when the resistance is equal to about $31\frac{1}{9}$ lbs. and his uniform motion 2 feet per second.

The strength of a horse at a dead pull is generally estimated at about 420lbs. and his greatest rate of walking 10 feet per second; therefore the greatest effect is produced when the load $= 186\frac{2}{3}$ lbs. and the velocity $\frac{10}{3}$, or $3\frac{1}{3}$ feet per second. A machine driven by the impulse of a stream produces the greatest effect when the wheel moves with one-third of the velocity of the water.

Machine *for Raising and Lowering Ladders, Scaffolding Poles, &c.—Description.* Fig. 1 is a side elevation of the machine, with ladders E on it, ready for raising. A is a drum for the rope F to work on, with a wheel on its axle for the wheel B to work on, turned by the handle 4, fig. 2. C C C C, wheels for the ready conveyance of the machine. D D, two rollers for the ladders to lay on, with guards on each end. E, ladders; from the drum A a rope works over the pulley H, and is fastened on the crook G. The pulley H is hooked on one of the ladder rooms. I is an earth-screw to fix the bottom of the ladders, when no other fastening presents itself; *f*, a small rope to fasten the ladders to the screw I; 2, 2, the frames, &c. Fig. 2 exhibits an end elevation of the machine.





N. B. On the back rails K steps may be fixed, in order to assist the apparatus.

*The* Machine *at Marly*, being so much celebrated, on account of its magnificence and the multiplicity of its parts, we shall here give some account of it from Gregory's Mechanics. This machine, which was erected by one Rannequin, of the country of Liege, and began to work in 1682, is situated between Marly and the village de la Chaussée: in that place the river is barred up, partly by the machine, and partly by a dam which keeps up the water; but that the navigation may not be interrupted, two leagues above Marly a canal has been cut for the passage of boats and barges: there has also been erected (about 30 fathoms from the machine) a contrivance called an *ice-breaker*, to prevent floating pieces of ice or timber which come down the stream from damaging the machine; and the better to secure the penstocks and the channels in which the wheels move, there is a grate of timber, to stop whatever may come through the ice-breaker. The water is raised to its destined height by means of 14 wheels, which serve to work the pumps, by three different stages: first, from the river to a reservoir, at the elevation of 160 English feet above the level of the Seine; then to a second reservoir, 346 feet higher; and from the latter to the summit of a tower, rather more than 533 feet above the river. The breadth of the machine comprehends 14 jets, or water-courses, shut by sluices or penstocks, which are raised and depressed by racks; and in each of these jets is placed a wheel: these wheels are disposed on three lines; in the first, on the side which points up the stream there are seven, six in the second, and only one in the third. The ends of the axle of each wheel go beyond their bearing-pieces, and are bent into a crank, which makes a lever of two feet; and it is to be observed, that the crank which is towards the mountain sucks and lifts up the water of the river, to drive it into the first cistern, and the other crank gives motion to the balances. Six of the wheels on the first line give motion by one of their cranks to an engine of eight pumps, without reckoning the feeder: these engines are compounded of a regulator, at each end of which hangs a square piece of wood, that carries and directs four pistons; the regulator is put in motion by two beams or leaders, one of which lying along, answers to the crank of the wheel and a vertical regulator, and the other hanging down, is united to the same regulator and to the balance. Of the six wheels we have mentioned, there are five which by their other crank give motion to the pumps that work in the cistern of the first lift, by means of horizontal levers and chains that communicate the motion. The sixth wheel, which is the first towards the dam, moves a long chain that works the pumps of one of the wells of the upper cistern, which is called the cistern of the great *chevalets*. Each of the cranks of the seventh wheel of the first line moves a chain which goes to the first cistern. The six wheels of the second line move, by each of their cranks, a chain that goes to the upper cistern, which (reckoning the chain that comes from the sixth wheel of the first line) makes 13 chains. These chains go over one of the cisterns of the first lift; and five of them at the same time give motion to the pistons of thirty pumps, whilst the other chains go on straight to the upper cistern. Lastly, the wheel, which is on the third line, by each of the cranks, works an engine of eight sucking and lifting pumps, and of itself supplies one conduit pipe. The seven chains of the wheels of the first line, in going along, work also eight sucking pumps placed a little below the cistern of the first lift, because in that place there are the waters of a considerable spring brought thither by an aqueduct; and these same chains take up that water the second time, to force it by 49 pumps into the upper reservoir, through two conduit pipes of eight inches, and three others of six inches diameter. The thirty pumps of the cistern of the first lift drive their water also through two pipes of eight inches diameter, which carry it into the upper cistern. The water raised at the two cisterns in the way up the hill discharges itself into a great reservoir, and thence, by two conduit pipes, of a foot diameter each, it runs into reservoirs of communication to be distributed into the several wells or little cisterns of the upper cistern, whence it is raised by 82 pumps, through six conduit pipes of eight inches' diameter, up into the tower which answers to the aqueduct. The eight great chains that go straight to the upper cistern, without moving any engines by the way, work sixteen pumps behind the upper cistern, to bring back into the reservoir of the said cistern the water which is lost out of the six pipes that go to the tower. The eight engines which suck and lift the water from the river contain 64 pumps: the two cisterns in the way up the hill together contain 79 pumps, and the upper cisterns 82, to which adding the sucking pumps called feeders, and the 8 others which are below the midway cistern, and besides the 16 pumps which we mentioned as placed behind the upper cistern, the machine has in all 253 pumps. The basin of the tower which receives the water raised from the river, and supplies the aqueduct, is 610 fathoms distant from the river. The water having run along an aqueduct of 36 arches, is separated into different conduits which lead it to Marly, and formerly conveyed it also to Versailles and Trianon. Such is the mechanism of the machine of Marly. Its mean produce is from 30,000 to 40,000 gallons of water per hour. We say *mean* produce, because, under certain favourable circumstances, it raises more than 60,000 gallons per hour. But during inundations, or when the Seine is frozen, when the water is very low, or when any repairs are making, the machine stops in great measure, if not entirely. The annual expense of the machine, including the salaries of men, &c. is about £9 a day.

MACLAURIN, Colin, a very celebrated mathematician, was born in Argyleshire, in February 1798. In his 12th year he is said to have made himself master of the first six books of Euclid in a few days without any assistance, having met with the book by accident, and studied as it were for his amusement. —In 1717 he was appointed professor of mathematics in the Marischall college, Aberdeen, and was soon after admitted a fellow of the Royal Society, of which he was a very useful member. He died in June, 1746, in the 48th year of his age. He was a good as well as a great man, beloved and admired by the greatest geniuses of his time, by Newton, Hoadly, Clarke, Folkes, Earl Morton, &c.

MACULÆ, in Astronomy, dark spots appearing in the luminous faces of the sun, moon, and even some of the planets. In this sense the maculæ stand contradistinguished from the faculæ, which are luminous spots. The solar maculæ are of an irregular changeable figure, observed first by Galileo in 1610, soon after he had finished his telescope, and about the same time by Huygens and Hevelius, Mr. Flamstead, Cassini, Kirch, &c. Many of these maculæ appear to consist of heterogeneous parts, of which the darker and more dense are called by Hevelius nuclei, and are encompassed as it were with atmospheres somewhat rarer, and less obscure, but the figure both of the nuclei and entire maculæ is variable. In 1644 Hevelius observed a small thin macula, which in two days extended ten times its bulk, appearing withal much darker, and with a larger nucleus; and such sudden mutations are frequent. The nucleus began to fail sensibly before the spot disappeared, and before that it quite vanished it broke into four, which in two days again re-united. Some maculæ have lasted fifteen, twenty, thirty, but seldom forty days; though Kirch observed one in 1681, which remained from April 26th to the 17th of July. The spots move over the sun's disc with a motion somewhat slower nearer the limb than the centre. That observed by Kirch was twelve days visible on the sun's disc; for fifteen days more it lay behind it, it being usual to return to the limb whence they departed, in twenty-seven, and sometimes in twenty-eight days. The different figures of the solar spots, varying from the circular form to the respective widths of an elliptical shape, is produced by the gradual recession of the same spots from the middle or front of the sun's disc to his edge, by the rotation of this star on its axis. Various hypotheses have been invented to account for these spots; some considering them as dark clouds floating in the solar atmosphere, others as real excavations, which have not the property of propagating light as the other parts of this luminary, the depth of some of them having been estimated at more than 4000 miles, and their orifices much exceeding this in diameter; some of them, indeed, from the angle they subtend, must exceed in size the whole globe of the earth.

Dr. Herschel has offered some conjectures on this subject, in the Philosophical Transactions for 1795 and 1801; those variations in the state of the weather, in different years, may arise, he thinks, from the greater or less number of maculæ on the solar disc.

MADDER, a rough trailing plant, that grows wild in the south of Europe, and is much cultivated in England and Holland as a dye-wood for calico printers. The roots afford the dye. But the madder of Smyrna and Cyprus excels for its bright and beautiful red colour. The roots of the plant, after being dug up, are carefully peeled, and dried in an open airy shade, and afterwards in a kiln, in the same way as hops are dried in Kent. The next process, of pulverizing or chopping them, was long a secret with the Dutch; but we have machines now in Glasgow and Manchester, that do this in the most superior style.

MADREPORA, in Natural History, the name of a genus of submarine substances, belonging to the order Athophytæ.

MADRIGAL. A short amorous poem of unequal verses, not confined either to the regularity of a sonnet, or to the point of an epigram. A beautiful, noble, and delicate thought, expressed with elegant simplicity, falls under this denomination.

MAGAZINE, a place in which stores are kept, of arms, ammunition, provisions, &c.

Magazine, *Powder*, ought to be fire and bomb proof; semicircular, 60 feet within the foundations, being 8 feet thick, and 8 high to the spring of the arch.

Magazine, *Artillery*, in a siege, is made about 25 or 30 yards behind the battery, towards the parallels, and at least 3 feet under ground.

Magazine, is also a term applied to a periodical publication; as, the *Imperial Magazine*, the *Philosophical Magazine*, &c. The number of these monthly publications is very great, and the knowledge they diffuse is proportionate to their numbers.

MAGELLANIC Clouds, the name given to three permanent whitish appearances, resembling the milky way, near the south pole, being distant from it about 11 degrees.

MAGI, or Magians, an ancient religious sect in Persia, and other eastern countries, who maintained, that there were two principles, the one the cause of all good, the other the cause of all evil; and, abominating the adoration of images, worshipped God only by fire, which they looked upon as the brightest and most glorious symbol of Oromasdes, or the Good God; as darkness is the truest symbol of Arimanius, or the Evil God. This religion was reformed by Zoroaster. The sect still subsists in Persia, under the denomination of *Gaurs*.

MAGIC, originally signified only the knowledge of the more sublime parts of philosophy; but as the magi likewise professed astrology, divination, and sorcery, the term magi became odious, being used to signify an unlawful, diabolical kind of science, acquired by the assistance of the devil and departed souls. Natural magic is only the application of natural philosophy to the production of surprising but yet natural effects.

|   |   |   |
|---|---|---|
| 4 | 9 | 2 |
| 3 | 5 | 7 |
| 8 | 1 | 6 |

Magic *Square*, is a square divided into cells, in which the natural numbers from 1 to the proposed square are so posited, that the sum of each row, whether taken horizontally, vertically, or diagonally, is equal to a certain given number; thus, in the annexed figure, which contains 9 cells, the sum of the numbers in each row is equal to 15.

De Lahire gives the following rule for filling up the cells in any square consisting of an odd number of units, *viz.*

|   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|
| 22 | 47 | 16 | 41 | 10 | 35 | 4 |
| 5 | 23 | 48 | 17 | 42 | 11 | 29 |
| 30 | 6 | 24 | 49 | 18 | 36 | 12 |
| 13 | 31 | 7 | 25 | 43 | 19 | 37 |
| 38 | 14 | 32 | 1 | 26 | 44 | 20 |
| 21 | 39 | 8 | 33 | 2 | 27 | 45 |
| 46 | 15 | 40 | 9 | 34 | 3 | 28 |

Place the least term 1, in the cell immediately under the middle or central one, and the rest of the terms, in their natural order, in a descending diagonal direction, till they run off either at the bottom or on the side. When the number runs off at the bottom, carry it to the uppermost cell which is not occupied, of the same column that it would have fallen in below, and then proceed, descending diagonally again as far as you can, or till the numbers either run off at the bottom or side, or are interrupted by coming at a cell already filled. When any number runs off at the right hand side, then bring it to the farthest cell on the left hand of the same row or line it would have fallen in towards the right hand; and when the progress diagonally is interrupted, by meeting with a cell already occupied by some other number, then descend diagonally to the left from this cell till an empty one is met with, where enter; and thence proceed as before. This rule, with reference to the above square, will be readily understood by the ingenious reader without further explanation.

Magic *Square of Squares*, is an extension given to the magic square, by Dr. Franklin. Here a great square of 256 little squares, in which all the numbers from 1 to $16^2$ or 256, are placed in 16 columns, which, taken either horizontally or vertically, possess several curious properties, but which we are obliged to omit detailing, for the introduction of more important matter.

MAGIC *Circle of Circles*, is an invention of Dr. Franklin's, founded on the same principles and possessing similar properties to the magic square of squares, by the same author. This consists of eight concentric circles and eight radii, in the circumferences of which all the natural numbers from 12 to 75 are so posited, that the sum of the number in each circumference, together with the central number 12, is equal to 360; and the numbers in each radius, including always the central number, also is equal to 360. Besides the above, these circles possess several other curious properties. The position of the numbers in each radius is as below, beginning with the outward number, and proceeding thence towards the centre, which is always 12, and common to each radius.

| 1st rad. | 2d rad. | 3d rad. | 4th rad. | 5th rad. | 6th rad. | 7th rad. | 8th rad. |
|---|---|---|---|---|---|---|---|
| 62 | 73 | 14 | 25 | 30 | 41 | 46 | 57 |
| 24 | 15 | 72 | 63 | 56 | 47 | 40 | 31 |
| 71 | 64 | 23 | 16 | 39 | 32 | 55 | 48 |
| 17 | 22 | 65 | 70 | 49 | 54 | 33 | 38 |
| 69 | 66 | 31 | 18 | 37 | 34 | 53 | 50 |
| 19 | 20 | 67 | 68 | 51 | 52 | 35 | 36 |
| 60 | 75 | 12 | 27 | 28 | 43 | 44 | 59 |
| 26 | 13 | 74 | 61 | 58 | 45 | 42 | 29 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |

Here the successive horizon lines will represent the several circumferences, and the vertical ones the radii, the sums in each being 360.

MAGNA CHARTA, the great charter of the liberties of England, and the basis of our laws and privileges. It was first obtained by the barons, sword in hand, from king John, and was ratified by various subsequent kings.

MAGNESIA. This is a family of minerals which comprehends all the combinations of magnesia with acids. When freed from extraneous matters, magnesia is a powdery substance of a limpid white colour.

*Epsom Salts*, or *Sulphate of* MAGNESIA, consists of magnesia in conjunction with sulphuric acid. It is said, that Epsom salts have been found in the Alps and in Switzerland under a powdery form, and sometimes even in masses, or a state of incrustation on stones and rocks. They are, however, chiefly found dissolved in mineral waters, and particularly in those at Epsom in Surrey and Seidlitz in Bohemia. Their taste is bitter and unpleasant. So little are they affected by exposure to the air, that the Abbé Haüy kept some by him for more than 12 years without any sensible alteration. These salts are much used in medicine, and are sometimes manufactured from the waters of Epsom and Seidlitz, but more frequently and in much greater abundance from sea water. The magnesia of the shops is prepared by dissolving Epsom salts in water, and adding to the solution half their weight of potash. The substance that sinks to the bottom is magnesia; and this, washed with a sufficient quantity of water and dried, has the appearance of a light, soft, and white powder, of insipid taste Magnesia is used in medicine, both in a simple state and when calcined or burnt. It is also employed in some chemical processes; and is in considerable request in the manufacture of enamel and porcelain. If putrid water be agitated with a small quantity of magnesia, it will lose a considerable portion of its bad taste and smell.

MAGNET, LOADSTONE, a ferruginous stone, which is endowed with the property of attracting iron, of pointing itself in a certain direction, and of communicating the same property to iron or steel bars. *See* MARINER'S COMPASS.

*The Poles of a* MAGNET, are those points which seem to possess the greatest power, or in which all the virtue appears to be concentrated. The *Magnetical Meridian*, is a vertical circle in the heavens, which intersects the horizon in the points to which the magnetic needle when at rest directs itself. The *Axis of a Magnet*, is a right line which passes from one pole to another. The *Equator of a Magnet*, is a line perpendicular to the axis, and exactly between the poles.

The distinguishing and characteristic properties of a magnet are as follows:—1. Its attractive and repulsive power. 2. Its directive power. 3. Its dip or inclination to a point above or below the horizon. 4. Its power of communicating its own properties to certain other bodies.

*Phenomena of the Magnet.*—These are numerous, but some of the principal are as follows:—1. A magnet, when freely supported by a thread, or in a light vessel on water, will place itself in a direction nearly coinciding with the poles of the earth. 2. This direction of the needle is not the same in all parts of the world, nor in the same place at different times. 3. A needle, not magnetized, being exactly balanced, will, if touched by a magnet so as to communicate that property to it, have its equilibrium destroyed, one of its extremities dipping considerably below the horizontal plane. 4. The centres of action of a magnet are at a small distance from its extremities, and the law of attraction from these centres is reciprocally as the squares of the distances. 5. When a magnetic needle is put out of its natural line of direction, the force with which it tends to regain that position varies as the sine of the angle subtended by its natural direction and that in which it is placed. 6. In every magnet there are two poles, of which the one points northwards, the other southwards; and if the magnet be divided into any number of pieces, the two poles will be found in each piece. The poles of a magnet may be found by holding a very fine short needle over it, for where the poles are, the needle will stand upright, but no where else.

Thus, in fig. 1, of the horse-shoe magnet, N indicates the north, and S the south pole of the magnet. By the following method also, the situation of the poles, and the direction of the (supposed) magnetic effluvia passing out of the stone, may be exhibited:—Strew about the poles of the stone on every side, iron or steel filings on a sheet of white paper; these small particles will be affected by the effluvia of the stone, and be so disposed as to shew the course and direction of the magnetic particles in every part. Thus, fig. 2, in the middle of each pole, it appears to go nearly straight on; towards the sides it proceeds in lines more and more curved, till at last the curve-lines from both poles exactly meeting and coinciding, form numberless curves on each side, nearly of a circular figure.

*Fig.* 1.

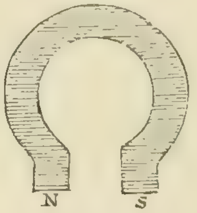
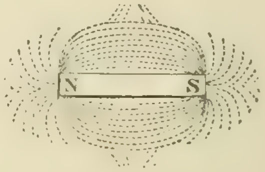


*Fig.* 2.



A small artificial magnet may be used in this experiment, instead of the real magnet, with a similar effect, if the table on which the paper rests receives a few gentle knocks, so as to shake the filings a little, otherwise the action of the magnet will not be sufficient to dispose properly those particles which lie at a considerable distance.

7. These poles, in different parts of the globe, are differently inclined towards a point under the horizon. 8. These poles, though contrary to each other, help mutually towards the magnet's attraction, and suspension of iron. 9. If two magnets be spherical, one will turn or conform itself to the other, as either of them would do to the earth; and after they have so conformed or turned themselves, they have a tendency to approach or join each other; but if placed in a contrary position, they repulse each other. 10. If a magnet be cut through the axis, the segments or parts of the stone, which before were joined, will now repel each other. 11. If the magnet be cut perpendicular to its axis, the two points which were before conjoined, will become contrary poles; one in the one, and one in the other segment. 12. Iron receives virtue from the magnet by application to it, or barely from an approach towards it, though it do not touch it; and the iron receives its virtue variously, according to the parts of the stone it is made to touch, or even approach to. 13. If an oblong piece of iron be any way applied to the stone, it receives virtue from it only lengthways. 14. A needle touched by a magnet will turn its

end the same way, towards the poles of the world, as the magnet itself does. 15. Neither the magnet, nor needles touched by it, conform their poles exactly to those of the world, but have usually some variation from them; and this variation is different in different places, and at divers times in the same places. 16. A magnet will take up much more iron, when armed or capped, than it can alone. 17. A strong magnet at the least distance from a smaller or a weaker, cannot draw to it a piece of iron adhering actually to such a smaller or weaker stone; but if it touch it, it can draw it from the other: but a weaker magnet, or even a small piece of iron, can draw away or separate a piece of iron, contiguous to a larger or stronger magnet. 18. In north latitudes the south pole of a magnet will raise up more iron than its north pole. 19. A plate of iron only, but no other body interposed, can impede the operation of the magnet, either as to its attractive or directive quality.

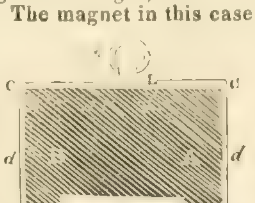
20. The power or virtue of a magnet may be impaired by lying long in a wrong position, as also by rust, wet, &c. and may be quite destroyed by fire, lightning, &c. 21. A wire being touched from end to end with one pole of a magnet, the end at which you begin will always turn contrary to the pole that touched it; and if it be again touched the same way with the other pole of the magnet, it will then be turned the contrary way. 22. If a piece of wire be touched in the middle with only the pole of the magnet, without moving it backwards or forwards, in that place will be the pole of the wire, and the two ends will be the other pole. 23. If a magnet be heated red-hot, and again cooled, either with its south pole towards the north, in a horizontal position, or with its south pole downwards in a perpendicular position, its poles will be changed. 24. Hard iron tools well tempered, when heated by a brisk attrition, as filing, turning, &c. will attract thin filings, or chips of iron, steel, &c. and hence we observe that files, punches, augres, &c. have a small degree of magnetic virtue.

25. The iron bars of windows, &c. which have stood a long time in an erect position, grow permanently magnetical; the lower ends of such bars being the north pole, and the upper end the south pole. 26. Tongs and fireforks, by being often heated, and set to cool again, in a posture nearly erect, have gained this magnetic property. Sometimes iron bars, by long standing in a perpendicular position, have acquired the magnetic virtue in a surprising degree. A bar about ten feet long and three inches thick, supporting the summer beam of a room, was able to turn the needle at eight or ten feet distance, and exceeded a loadstone of three pounds and a half weight; from the middle point upwards it was a north pole, and downwards a south pole.

27. A needle well touched, it is known, will point nearly north and south; but if it have one contrary touch of the same stone, it will be deprived of its faculty, and by another such touch it will have its poles interchanged.

28. A magnet acts with equal force in vacuo as in the open air. The smallest magnets have usually the greatest power in proportion to their bulk. A large magnet will seldom take up above three or four times its own weight, while a small one will often take up more than ten times its weight. A magnet worn by Sir Isaac Newton in a ring, and which weighed only 3 grains, would take up 746 grains, or almost 250 times its own weight. A magnetic bar made by Mr. Canton, weighing 10 oz. 12 dwts. took up more than 79 ounces; and a flat semicircular steel magnet weighing 1 oz. 13 dwts. took up an iron wedge of 90 ounces.

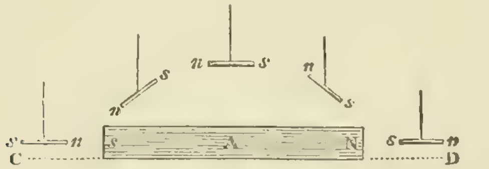
*Armed* MAGNET, denotes one that is capped, cased, or set on iron or steel, to make it take up a greater weight, and also more readily to distinguish its poles. The magnet in this case is mounted with two pieces of iron, which are called the armature. The figure represents an armed magnet, where A B is the loadstone; C D, C D, are the armature, or the two pieces of soft iron, to the projections of which, D, D, the iron weight E is to be applied. The dots E, L, *d*, L, *d*, represent the brass box, with a ring at E, by which the armed magnet may be suspended.



*Artificial* MAGNET, is a bar of iron or steel impregnated with the magnetic fluid, and possessing all the properties of the magnet itself, and commonly in a much higher degree. There are various methods of communicating the power of a magnet to bars of iron and steel, whereby these last become themselves magnets, and capable of again transmitting their power to others, and so on. There are also several ways of making artificial magnets without the assistance of any magnet whatever. Procure a dozen bars, six of soft steel and six of hard; the former to be each three inches long, ¼ of an inch broad, and the 20th of an inch thick, with two pieces of iron, each half the length of one of the bars, but of the same breadth and thickness, and the six hard bars to be each 5½ inches long, ½ an inch broad, and $\frac{3}{20}$ths of an inch thick, with two pieces of iron half the length, but the whole breadth and thickness, of one of the hard bars; and let all the bars be marked with a line quite round them at one end. Then take up an iron poker and tongs, or two bars of iron, the larger they are and the longer they have been used, the better; and fixing the poker upright between the knees, hold to it near the top, one of the soft bars, having its marked end downwards, by a piece of sewing silk, which must be pulled tight by the left hand, that the bar may not slide; then grasping the tongs with the right hand a little below the middle, and holding them nearly in a vertical position, let the bar be stroked by the lower end from the bottom to the top, about ten times on each side, which will give it a magnetic power sufficient to lift a small key at the marked end, which end, if the bar were suspended on a point, would turn towards the north, and is therefore called the north pole; and the unmarked end is for the same reason called the south pole: four of the soft bars being impregnated after this manner, lay two of them parallel to each other, at one-fourth of an inch distance, between the two pieces of iron holding them, a north and south pole against each piece of iron; then take two of the four bars already made magnetical, and place them together so as to make a double bar in thickness, the north pole of one even with the south pole of the other; and the remaining two being put to these, one on each side, so as to have two north and two south poles together, separate the north from the south poles at one end by a large pin, and place them perpendicularly with that end downwards on the middle of one of the parallel bars, two north poles towards its south end, and the two south poles towards its north end; slide them three or four times backward and forward the whole length of the bar; then removing them from the middle of this bar, place them on the middle of the other bar, as before directed, and go over that in the same manner; then turn both the bars the other side upwards, and repeat the former operation; this being done, take the two from between the pieces of iron, and placing the two outermost of the touching bars in their stead, let the other two be the outermost of the four to touch these with; and this process being repeated till each pair of bars have been touched three or four times over, will give them a considerable magnetic power. Put the half dozen together after the manner of the four, and touch them with two pair of the hard bars placed between their irons, at the distance of about half an inch from each other; then lay the soft bars aside, and with the four hard ones let the other two be impregnated, holding the touching bars apart at the lower end near two-tenths of an inch; to which distance let them be separated after they are set on the parallel bar, and brought together again before they are taken off: this being observed, proceed according to the method described above, till each pair has been touched two or three times over; but as this vertical way of touching a bar will not give it quite so much of the magnetic virtue as it will receive, let each pair be now touched once or twice over, in their parallel position, between the irons, with two of the bars held horizontally, or nearly so, by drawing at the same time the north end of one from the middle over the south end, and the south of the other from the middle over the north end of a parallel bar; then bringing them to the middle again without touching the parallel bar, give three or four of these horizontal strokes to each side. The horizontal touch, after the vertical, will make the bars as strong as they possibly can be made, as appears by their not receiving any additional strength, when the vertical touch is given by a great number of bars, and the horizontal by those of a superior magnetic power..

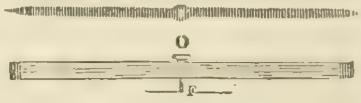
This whole process may be gone through in about half an hour; and each of the large bars, if well hardened, may be made to lift twenty-eight Troy ounces, and sometimes more. And when these bars are thus impregnated, they will give to a hard bar of the same size its full virtue in less than ten minutes; and therefore will answer all the purposes of magnetism in navigation and experimental philosophy, much better than the loadstone, which has not a power sufficient to impregnate hard bards. The half dozen being put into a case in such a manner as that no two poles of the same name may be together, and their irons with them as one bar, they will retain the virtues they received; but if their power should, by making experiments, be ever so far impaired, it may be restored without any foreign assistance in a few minutes. And if perchance a much larger set of bars should be required, these will communicate to them a sufficient power to proced with; and they may in a short time, by the same method, be brought to their full strength.—*Barlow, Phil. Tran.*

To illustrate the magnetical inclination or dip of the needle, take a globular magnet, or, which is more easily procured, an oblong one, like S. N. in the figure; the extremity N, of which is the north pole; the other extremity, S, is the south pole, and A is the middle or equator; place it horizontally upon a table C D, then take another small oblong magnet, *ns*, *viz.* a bit of steel wire, or a small sewing needle magnetized, and suspend it by means of a fine thread tied to its middle, so as to remain in an horizontal position when not disturbed by the vicinity of iron, or other magnet. Now, if the same small magnet being held by the upper part of the thread, be brought just over the middle of the large magnet within two or three inches of it, the former will turn its south pole *s*, towards the north pole N of the large magnet, and its north pole *n* towards the south pole S of the large one. It will be farther observed, that the small magnet, while kept just over the middle of the large one, will remain parallel to it; for since the poles of the small magnet are equally distant from the contrary poles of the large magnet, they are equally attracted. But if the small magnet be moved a little nearer to one end than to the other of the large magnet, then one of its poles, *viz.* that which is nearest to the contrary pole of the large magnet, will be *inclined downwards*, and of course the other pole will be *elevated* above the horizon. It is evident that this inclination will increase according as the small magnet is placed near to one of the poles of the large one, because the attraction of the nearest will have more power upon it. If the small magnet be brought just opposite to one of the poles of the large magnet, it will turn the contrary pole towards it, and will place itself in the same straight line with the axis of the large magnet.

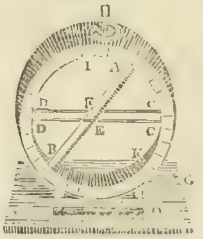


This simple experiment will enable the reader to comprehend easily the phenomena of the magnetic inclination, or of the dipping needle upon the surface of the earth; for it is only necessary to imagine, that the earth is a large magnet, (as it in fact appears to be,) and that any magnet, or magnetic needle commonly used, is the small magnet employed in the foregoing experiment. The direction of the dipping needle in any place is called the *magnetic line*.

The best shape of a magnetic needle is represented in these two figures, the first of which shews the upper side, and the second shews a lateral view of the needle, which is made of steel, having a pretty large hole in the middle, to which a conical piece of agate is adapted by means of a brass piece O, into which the agate is fixed. The apex of this hollow cap rests upon the point of a pin F, which is fixed in the centre of the box, and upon which the needle, being properly balanced, turns very nimbly. For common purposes, these needles have a conical perforation made in the steel itself, or in a piece of brass, which is fastened in the middle of the needle.



The dipping needle, though of late much improved, is however still far from perfection. The general mode of constructing it is, to pass an axis quite through the needle, to let the extremities of this axis, like those of the beam of a balance, rest upon its supports, so that the needle may move itself vertically round, and, when situated in the magnetic meridian, it may place itself in the magnetic line. The *degrees of inclination* are shewn upon a divided circle, in the centre of which the needle is suspended. This figure represents a dipping needle of the simplest construction:—A B is the needle, the axis of which F E rests upon the middle of two lateral bars C D, C D, which are made to the frame that contains the divided circle A I B K. This machine is fixed on a stand G, but when used at sea it is suspended by a ring H, so as to hang perpendicularly. When the instrument is furnished with a stand, a spirit level O is generally annexed to it, and the stand has three screws, by which the instrument is situated, so that the centre of the needle, and the division of 90 on the lower part of the divided circle, may be exactly in the same time perpendicular to the horizon.

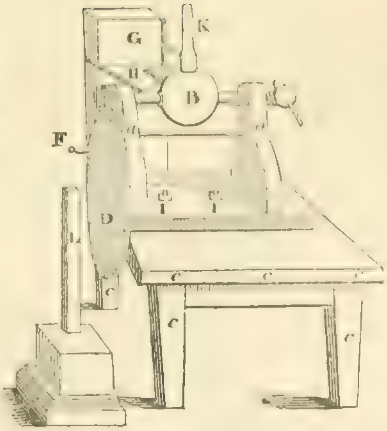


*An Account of the Experiments of Peter Barlow, of the Royal Military Academy, on the Magnetism induced or exhibited in Iron and other Metals by rotation.*

Availing himself of one of the turning lathes, in the royal arsenal, an attempt was made by this gentleman to ascertain whether, by giving to an iron body a rapid rotation, any change could be distinguished in its magnetic state during the motion, or after it had subsided; accordingly, a small howitzer shell was attached to a lathe, admitting of a rapid motion, and a small compass being placed very near to it, it was perceived at once that the needle was considerably deflected, but it returned to its original direction as soon as the motion ceased. A thirteen-inch shell was then fixed to the mandrel of one of the large lathes worked by the steam engine, and the effect obtained was of course proportionably greater. In fact, with this shell, the direction of the needle was, in many cases, reversed by the motion of the former; but there were other points in which no motion could be observed.

Moreover, in several instances the deviation of the needle was made in a contrary way to what it was in others, varying in quantity as stated above, from zero to 180°, according to the situation of the needle; the distance and the rate o. motion being the same. In all cases, by reversing the motion of the shell, the deviation was reversed also; so that if with the shell turning one way, the needle deviated to the esst, it deviated to the west when the shell was turned in an opposite direction; and in all cases during the rotation of the shell, the needle preserved its deviating direction remarkably steady, viz. without any kind of oscillation or tremor; but the moment the motion ceased, it returned to its original and true bearing. The effect produced was therefore temporary, and depended entirely on the velocity of rotation.

These were all the deductions of any importance drawn from the first series of experiments; and as the steam-engines were not set to work again for some time, no farther observations were made, 'till Mr. Barlow, finding himself embarrassed with the iron work of the lathes and other machines, had an apparatus constructed, which he erected on his own premises, and by means of which he at length succeeded in deducing the laws which regulate and determine the direction of the needle in all cases, and in all situations. The results have been presented to the Royal Society, and the following concise account of them may be acceptable to our readers:—



This apparatus consists of a frame, *a a*, resembling that on which the cylinder of an electrical machine is hung; the ball B supplying the place of the cylinder, the diameter of the ball or shell was eight inches, and its weight about 30 lb. A strong table *c c c c*, fixed with its feet into the ground, the floor of the room being cut away so as to prevent any shaking of the floor or walls. The diameter of the larger wheel D was 18 inches; of the smaller E, three inches; and the handle F might be turned with ease twice in a second, which gave about 720 revolutions per minute to the shell. A stand G, made heavy by being loaded with sand, had a small platform H attached; it might be brought up close to the shell, and the suspended compass H, surrounded by a glass tube K, placed near the same, at any azimuth, and on either side. Moreover, there were several holes in the table, which enabled the experimenter to screw down the frame itself in any azimuth, by means of the fly nuts I I. The ball could only revolve with its axis horizontal, but it could be made to revolve direct or reverse at pleasure. The platform might be depressed or raised to any height, and the needle thus placed over or under any proposed point of the shell.

Things being thus prepared, the platform was first placed in the horizontal plane of the ball's axis, and the needle placed successively at every point all round. And it appeared that whatever might be the azimuth of the needle, (provided it was neutralized by the magnet, L, from the directive power of the earth,) on turning the ball, the north end of the needle *approached* towards it when the motion was towards the needle, but *receded* when the motion was *from the needle*. That is, when the upper part of the shell, by the revolution, descended towards the needle, the north end of the needle approached towards the shell; but when the ball revolved in an opposite direction, then the south end of the needle approached, or the north end receded.

When the needle was carried round the shell in a vertical circle, ascending 10° each time, the following results were observed, (the needle being in every case neutralized, and placed parallel to the axis of rotation,) viz. from the horizon to an altitude of about 54°, the needle placed itself perpendicularly to the axis of the north end, passing the contrary way to that in which the motion of the shell was made; from 54° to 90°, or to the zenith of the ball: the needle also placed itself perpendicularly to the axis, but in a reversed position to what it took up before, viz. the north end passed in the direction of motion in the shell. It did the same on the other side of the vertical, to a like point or altitude of about 54°; but from that point to the horizon it arranged itself as at first. Below the horizon it also preserved the same direction till it amounted again to 54°; it then changed its direction, as when above the horizon. There were, therefore, four points of change in the direction of the needle, (the motion of the ball remaining the same,) viz. at 54° above and below the horizon of the ball, on each side of the zenith and radius. It will of course be understood, that by reversing the motion of the ball, the needle also changed its direction, but the points of change remained the same; and that the effect was independent of the direction of the axis of motion, viz. whether the axis was east and west, north and south, or in any other azimuth; but it required a certain velocity, not less than 600 revolutions per minute, to produce the full effect. It is obvious, therefore, that the mere rotation of an iron shell impresses upon it, during the motion of the same, a temporary magnetic effect, and that this effect ceases the moment the motion is discontinued.

The above experiments were begun in December, 1824; and it was not till April 1825, that Mr. Barlow learned that M. Arago had been making similar experiments in France, on copper and other metals, without being aware of their actual date. They were not known in England till Gay Lussac's visit to London at the time above stated. We are not aware of the precise nature of these experiments, and shall, therefore, only endeavour to describe those which Mr. Maish assisted Mr. Barlow in making, and which he founded on the description he had received. They may, therefore, be considered as the experiments of M. Arago, repeated and varied as different circumstances occurred, to suggest new ideas. The account he had of M. Arago's experiments, was, that by placing a copper plate upon a vertical spindle, the plate being horizontal, and then placing just above it a light compass needle, but independent of course of the plate, or causing the spindle and plate to revolve, the needle was considerably deflected, and more and more as the velocity was increased, so that when the plate was put into rapid rotation, the needle also began after a few vibrations to revolve, and at length with considerable velocity.

1. In order to repeat this experiment, says Mr. Maish, I connected the wheel of my turning lathe with a vertical spindle, which I could make revolve forty-five times per second; and on this I placed a thin copper plate, about six inches diameter, and over this a needle about five inches long shut up in a close box, about one inch or rather less above the plate. When putting the lathe in motion, I found it to deflect the needle about five points, the deflection being always in the same direction as the motion of the plate, but we could not cause it to revolve. The needle was therefore partly neutralized by a bar magnet, and the experiment repeated. We then very soon obtained a considerable rotatory motion in the needle; and by using a larger and heavier plate, the same was produced afterwards without neutralizing the needle.

2. Another experiment, which was mentioned as one of M. Arago's, and which I repeated, was by interposing a plate of iron between the copper plate and the needle. In this case no effect could be produced on the needle by the rotation of the copper plate, the iron clearly intercepting the action.

3. I now tried a zinc plate instead of a copper plate, and the effect was nearly the same as before, but a little less.

4. An iron plate was now substituted, and the effect was considerably greater than with the copper-plate.

5. The copper plate was again replaced, and a brass needle placed in the box. Some motion was obtained, but it was very equivocal, so that I cannot venture to say that it was certainly due to the rotation.

6. A heavy horse-shoe magnet was now suspended by a line from the ceiling, and it was put in rotation by the revolution of the copper plate—a paper screen having been first interposed between them.

7. One copper plate was suspended over another, but no motion was obtained, and the same took place when the copper plate was suspended over an iron one.

8. A bar magnet rather shorter than the diameter of the copper plate was fixed horizontally to the upright spindle, and being made to revolve, the plate very soon acquired rotation. A paper screen was in this, as in the preceding experiments, interposed between the plate and magnet.

9. The plate was now applied immediately to the axis of the lathe, so as to cause it to revolve vertically, and the needle placed near to it, but no motion took place, till, by nearly neutralizing the needle, and bringing either of its poles directly to the plate, it then always deviated in the direction of the motion of the plate, whichever pole of the needle was directed to the former; the needle of course, therefore, deviated different ways, (all other things being the same,) when it was above or below the axis, but in the direct horizontal line of the axis no motion in the needle took place.

10. The above are the principal experiments that I assisted in making by revolving the plate, but these having suggested to Mr. Barlow that all the results obtained might be explained by supposing that there existed a slight magnetic power in copper, and in the various metals, which had a tendency to draw the needle after the plate, or the latter after the former, he endeavoured to exhibit this by direct experiment, independent of

volution. With this view, he neutralized a needle very accurately; and then applying very near to its poles the end of a round brass ruler, the attraction of the latter was obvious—it drew the needle several degrees,—then, withdrawing it, and catching the needle again in its returning vibration, it was drawn out some farther degrees, and in a very short time the deflection was converted into a revolution, which, by alternately presenting and withdrawing the brass ruler, was at length rendered very rapid.

11. The same result was obtained by two or three different pieces of brass; but there were other pieces, although of the same size and form, which had little or no effect.

The following experiment is due to Mr. Sturgeon of Woolwich.

12. A thin copper plate or wheel, about five or six inches in diameter, was suspended very delicately on an axis, and then on one side a little weighted, in order to give it a tendency to oscillate. The heavy point was now raised level with the axis of the plate, opposite to the heavy point was placed a quadrant divided from zero to 90 degrees, the number of vibrations the plate made before it came to 45 degrees was counted. The same was again done, with this difference only, that the vibrations now took place between the poles of a strong horse-shoe magnet, and the number of them before the plate fell to 45 degrees, was very little more than one half of what they were in the former instance.

This is the converse of M. Arago's experiments, in which he shews the effect of copper, and other metallic rings, in diminishing the number of oscillations of a magnetic needle.

13. If, instead of a horse-shoe magnet, the contrary pole of two bar magnets be used, the effect is the same as before: but if the poles of the same name, viz. both north or both south, be employed, then the effect is scarcely perceptible. This is an important result, as it shews that the effect is not due to any kind of resisting medium, as was supposed in the first instance.

The analogy subsisting between electricity and magnetism, the identity of lightning and electricity, and their effects in destroying the polarity of the magnetic needle, and in some cases reversing its poles, while in other instances lightning has communicated the magnetic power to pieces of steel that had not before any polarity, are facts well known. Various attempts have been made to establish the identity of electricity and magnetism by means of the galvanic battery, till Professor Oersted, of Copenhagen, in the year 1820, succeeded in demonstrating their reciprocal action on each other, by the most decisive and satisfactory experiments.

The galvanic batteries, generally used for the illustration of electro-magnetism, have been considered by Mr. Sturgeon as cumbersome and inconvenient, and he has succeeded in constructing one, which is neither expensive, cumbersome, nor difficult to manage. Yet with this small battery (which will only hold about half a pint of fluid) he was enabled to exhibit the whole train of electro-magnetic experiments.

Sturgeon's battery consists of two concentric copper cylinders, having a common bottom; they are about six inches in depth, and the outer one two inches diameter; between these is placed another cylinder of zinc without a bottom, insulated by three pieces of cork from the copper; two wires proceed from the zinc part of the arrangement, one supporting a small cup, the other bent downwards (and the like from the copper part) for the purpose of forming the various connexions necessary to make the experiments. The batteries themselves are attached to a wire fixed in a block of wood (forming a stand) by two gudgeons, one of which has a screw by which it can be fixed at any height required.

The apparatus for producing the deflection of the magnetic needle is represented in fig. 1. The wire proceeding from the zinc extremity of the battery being placed to the north, and the other end placed in the cup A, attached to the wire passing above the needle C, it was deflected to the west; and when the wire was placed in the cup B, connected with the wire passing below the needle, its deflection was towards the east. The needle with which this experiment was performed was eight inches long, half an inch wide, and nearly a quarter of an inch thick, and it was deflected from the plane of the magnetic meridian in an angle of from 60 to 70 degrees, upon completing the galvanic circuit. Pith balls were attached to the poles of the magnet, as in the figure, to render the deflection more visible to the spectators.

M. Arago's experiment of magnetizing a piece of iron, was performed with the apparatus represented in fig. 2. By completing the galvanic connexion, the piece of iron A B, contained within the spiral wire C, inserted in the cups *d* and *e*, became strongly magnetic, and attracted or repelled another magnet according as dissimilar or similar poles were presented. Its attractive power was very great, as its extremities supported two pieces of iron *f* and *g*, of several ounces weight, which on breaking the contact fell on the lecture table precisely as the lecturer had predicted. The bottoms of the cups are connected by a wire passing under the board upon which they are placed.

*Fig.* 1.

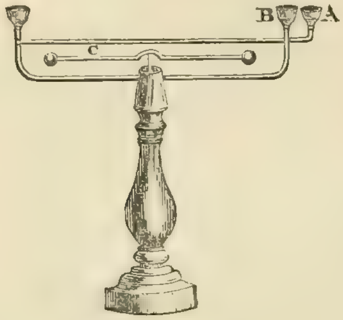
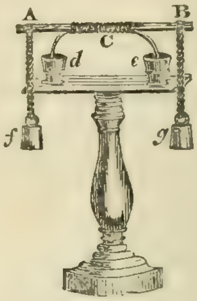
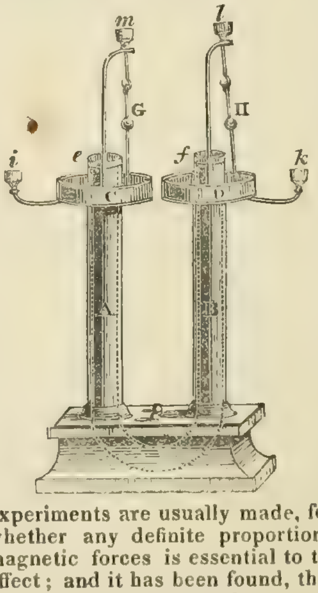


*Fig.* 2.



The beautiful apparatus for effecting the revolution of the galvanic wire about the magnet is here exhibited. The two upright pillars A and B are the legs of a horse-shoe magnet, concealed by brass cylindrical cases, the bottom of the magnet being inserted into a block of wood which forms a pedestal; the cups C and D, which are four inches in diameter, containing the mercury, are attached to two caps of pasteboard, *e* and *f*, which are made to fit the tops of the pillars; when the communication was made by connecting the zinc end of the battery with the cups *i* and *k*, and the copper extremity with the cups *l* and *m*, the wires *g* and *h* began to revolve very rapidly round the poles of the magnet in *contrary directions*. This was made very conspicuous by the pith balls fixed to the wires.



The advantage of employing large magnets in preference to small ones, in producing electro-magnetic phenomena, is well known. Many experiments are usually made, for the purpose of ascertaining whether any definite proportion between the galvanic and magnetic forces is essential to the production of the greatest effect; and it has been found, that the galvanic force might be reduced almost to any degree, provided the magnetic power is sufficiently great. This discovery has led to the use of powerful magnets, and small galvanic batteries.

Barlow's plate for neutralizing the action of the iron of ships in producing a deviation in the compass, is as follows, and for which discovery the board of longitude gave this gentleman £500:—The centre of a small circular iron plate is placed on the line of the attraction of the ship's iron, and at a proper distance behind and below the pivot of the compass needle, the position of this line having been ascertained previously to the ship's leaving port, an operation which will be greatly facilitated by a table for this purpose prepared by Mr. Barlow. When this is done, the needle will remain active and vigorous in the polar regions, and will direct itself in the true magnetic meridian, in whatever part of the world the ship is placed. This effect of the invention has been experimentally established between the 61° of south latitude and the 81° of north latitude, by the accurate observations of Lieutenant Foster, and by other naval officers. There are few scientific inventions of modern times more useful in practice than this.

*Scoresby's New Experiments on Magnetism*, are as follows:—Bars of steel could be rendered highly magnetic by hammering them in a vertical position, with the lower end resting upon a poker or rod of iron. This process, however, he has greatly improved by hammering the steel bars between two bars of iron: the steel bars were the eighth part of an inch in diameter. When only one bar of iron was used, a steel wire six inches long lifted a nail weighing 186 grains; but when two bars of iron were used, the wire lifted 326 grains. When the new process was employed with an iron bar eight feet long, a steel wire six inches long lifted 669 grains, or four times its own weight. The theory of the process is, that percussion on magnetizable substances in mutual contact inclines them to an equality of condition, in the same manner as all bodies of different temperatures tend to assume the same temperature when in contact. The two great iron bars being made magnetical by position, the interposed bar of steel will therefore, when thrown into a state of vibration by percussion, receive a portion of their magnetism. In like manner a magnet, when struck in the air with a piece of flint, or upon a body of inferior magnetic quality, will have its magnetism diminished

**MAGNETISM, Animal**, a pretended mode of curing all kinds of disease by means of a sympathetic affection between the sick person and the operator. Towards the conclusion of the 18th century, this scientific nostrum made a considerable noise in England, but soon fell into dispute. On the continent its life was a little more protracted, but in most places contempt arrested its progress, and oblivion became its grave. In Germany some few persons still affect to treat it with veneration, but its credit is irrecoverably lost, its boasted effects having been clearly traced to excited imagination.

**MAGNIFYING**, is used to denote the apparent enlargement of an object by means of a convex lens, or some other optical instrument, particularly the microscope. *See* LENS, MICROSCOPE, TELESCOPE, &c.

MAGNIFYING *Glass*, is a popular term for any convex glass or lens which has the property of magnifying.

**MAGNITUDE**, is used to denote the extension of any thing, whether it be in one direction, as a line; in two directions, as a surface; or in three directions, which constitute a body or solid.

*Geometrical* MAGNITUDES, may be conceived to be generated by motion, as a line by the motion of a point, a surface by the motion of a line, and a solid by the motion of a surface.

*Apparent* MAGNITUDE of a body, is that which is measured by the angle which that body subtends at the eye; at least, this is what is always to be understood by this expression in the science of optics, though in reality the apparent magnitude depends not only on the visual angle, but also upon the supposed distance of the object we are viewing. The mind judges of the magnitude of distant objects on two principles, *viz.* with reference to the optic angle, and the distance of the object from the eye, the latter arising out of our experience, which shews that distance diminishes that angle; and therefore, without being aware of the deduction, we always make a certain compensation agreeably to the supposed distance. If we see a man, or any other known object, at a distance, it conveys to our mind the idea of a certain magnitude, which we attribute to it entirely independent of the angle which it subtends; but if the object is unknown, then both the distance and the angle are considered, in forming an idea of its magnitude: it is thus that we sometimes deceive ourselves with regard to the size of an object, if we are mistaken as to its distance; thus, a small bird on the branch of a tree may appear to be a larger bird at a greater distance, or the contrary; thus also a fly imperfectly seen in the corner of window, may have the appearance of a crow flying in the open air; these are optical illusions which commonly happen, and which most persons accustomed to observation, recollect to have experienced at one time or other. It is on this principle, that some writers have accounted for the different apparent magnitudes of the sun and moon, and the apparent distance of two or more known stars, when seen near the horizon, and when they have a greater angle of elevation. When we see the moon, for example, at a considerable elevation, there being no intervening objects between that luminary and the eye, wherewith to make a comparison of its distance, we intuitively suppose it nearer than when we observe it in the horizon; because there are then numerous objects, many of them at great distances, and the moon being evidently beyond them all, we thence suppose its distance greater than in the former case, and the optic angle being still nearly the same, we attribute to it a greater magnitude in the horizon than in the zenith, because we suppose its distance then to be the greatest: hence also the apparent figure of the heavens, which instead of having the form of a perfect concave hemisphere, the eye being in the centre, it has always the appearance of being considerably flattened in the upper part, or being a segment considerably less than a hemisphere. This however is a subject that has much engaged the attention of astronomers and philosophers, from the earliest period to the present time; and various hypotheses have been advanced to account for it, none of which are perhaps perfectly satisfactory.

**MAGNOLIA**, the laurel-leaved tulip tree, a genus of plants belonging to the polyandria class. The flower of the magnolia is very magnificent, being a fine white, and of large dimensions. This tree loves a southern aspect, and requires to be well matted up during the severity of our winter.

**MAHOGANY.** The *Swietenia Mahagoni*, or mahogany-tree, is a native of the warmest parts of America, and grows also in the islands of Cuba, Jamaica, Hispaniola, and the Bahama islands. This tree grows tall and straight, rising often sixty feet from the spur to the limbs; and is about four feet in diameter. The foliage is a beautiful deep green, and the appearance made by the whole tree very elegant. The flowers are of a reddish or saffron colour, and the fruit of an oval form, about the size of a turkey's egg. Some of them have reached to a size exceeding one hundred feet in height. The mahogany-tree thrives in most soils, but varies in texture and grain according to the nature of the soil. On rocks it is of a smaller size, but very hard and weighty, and of a close grain, and beautifully shaded; while the produce of the low and richer lands is more light and porous, of a paler colour, and open grain; and that of mixed soils holds a medium between both. This wood is generally hard, takes a fine polish, and is found to answer better than any other sort in all kinds of cabinet ware.

**MAHOMETANS**, believers in the doctrines and divine mission of Mahomet, the celebrated warrior and pseudo-prophet of Arabia. The religion of Mahomet is divided into two general parts, faith and practice. The fundamental article of the Mahometan creed is contained in this one confession: *There is but one God, and Mahomet is his prophet.* Under these two propositions are comprehended six distinct branches, *viz.* belief in God, in his angels, in his scriptures, in his prophets, in the resurrection and judgment; or in God's absolute decrees, or predestination. They reckon five points relating to practice, *viz.* prayer with washings, &c. alms, fasting, pilgrimage to Mecca, and circumcision. Mahomet admitted the divine mission of both Moses and of Jesus Christ. Mahometism is a borrowed system, made up for the most part of Judaism and Christianity; and, if it be considered in the most favourable point of view, might possibly be accounted a sort of Christian heresy. Achmet Benabdalla, in his letter to Maurice Prince of Orange, says, "The Lord Jesus Christ is held by us (Mahometans) to be a prophet, and the messenger of God, and our lady, the Virgin Mary his mother, to be blessed of God, holy, who brought him forth, and conceived him miraculously by the almighty power of God."

**MAIDEN**, in ancient English customs, an instrument for beheading criminals. It was in form of a painter's easel, about ten feet high; at four feet from the bottom was a cross bar, on which the felon laid his head, which was kept down by another placed above. In the inner edges of the frame were grooves: in these were placed a sharp axe, with a vast weight of lead supported at the summit with a peg; to that peg was fastened a cord, which the executioner cutting, the axe fell, and severed the head from the body. This instrument is said to have been introduced into Scotland by the Regent Morton, who himself was afterwards executed by it. This apparatus is now in possession of the society of Scottish Antiquaries. But there is reason to believe it was known in Scotland prior to the time of Morton coming into power, for they shew, in the armoury at Aberdeen, the maiden with which Sir John Gordon was executed in the time of Queen Mary, after the defeat and death of his father the earl of Huntly, at Corrichie. In France, criminals have been put to death by the maiden or guillotine, since the horrible revolution.—*Maiden*, is also the name of a machine for washing linen, in Yorkshire.

MAIHEM, or Maim, signifies a corporal wound or hurt, by which a man loseth the use of any member.

MAIM, in Law, a wound by which a person loses the use of some member that might have been a defence to him, and this crime is felony, by 22 and 23 Charles II., without benefit of clergy, though no such attainder shall corrupt the blood, or occasion forfeiture of lands, &c.—*Cutting and Maiming* is also, by a recent statute, felony.

MAIN, an epithet applied to whatever is principal, as opposed to what is inferior or secondary; thus, the main land is used in contradistinction to an island, and the main mast, the main wale, the main keel, and the main hatchway, are in like manner distinguished from the fore and mizzen masts, the channel wales, the false keel, and the fore and after hatchways.

Main *Tackle*, a large and strong tackle, hooked occasionally on the main pendant, and used for various purposes, particularly in securing the mast, by setting up the rigging, stays, &c. See the article Pendant.

MAINPRIZE, a writ directed to the sheriff, commanding him to take sureties for a prisoner's appearance, (when the offence is bailable, or when the cause of commitment is not properly bailable " below,") and to set him at large. These sureties are termed *mainpernors*, and they can neither imprison nor surrender their man, as " bail," so called, can, but are barely sureties for his appearance at the day.

MAINTENANCE, in Law, nearly the same as *Barretry*, being an officious intermeddling in a suit that no way belongs to one, by maintaining or assisting either party with money, or otherwise, to prosecute or defend it. This is an offence against public justice; though a man may with impunity maintain the cause of his relation, kinsman, servant, or poor neighbour, out of charity.

MAISE, or Indian Corn, is a species of grain much cultivated in America and other countries: the grains are yellow when ripe, flat-shaped, like pressed pease, and grow in a sort of knot round the top of the plant. These plants are sown in March, April, or May, and usually yield two crops a year, at the rate of from 15 to 40 bushels per acre. Maise might, with advantage, be cultivated in England.

MAJESTY, a title given to kings.

MAKING-UP, among distillers, the reducing spirits to a certain standard of strength, usually called proof, by the admixture of water; which should be either soft and clear river water, or spring water rendered soft by distillation.

MALACHITE, a mineral, the green carbonate of copper, found frequently crystallized in long slender needles; colour green, specific gravity about 3·6. There are two varieties, the fibrous and the compact; the constituent parts are, copper 58·0; carbonic acid 18·0; oxygen 12·5; water 11·5.

MALACIA, in Medicine, a languishing disorder, incident to pregnant women, in which they long at one time for one kind of food, at another for some other kind of food, which they will eat with extraordinary greediness.

MALACOLITE, a mineral found in the silver mines in Sweden and Norway. It is obtained massive, and crystallized in six-sided prisms. Specific gravity 3.25. It consists of silica 53; lime 23; magnesia 19; alumina 3; oxide of iron, &c. 4.

MALACOPTERYGEOUS, in Ichthyology, an appellation given to fishes having the rays of their fins bony at the extremities, but not pointed, like those of acanthopterygeous fishes, or thorn-backs.

MALATES, in Chemistry, salts formed by the union of the malic acid with different bases. The malates of potash, soda, ammonia, lime, and barytes, may be formed by dissolving these alkalies in malic acid, and evaporating the solution.

MALE, among zoologists, that sex of animals which has the part of generation without the body. The term male has also been applied to several inanimate things: thus we say a male-flower, a male-screw, &c.

MALIC Acid, is found in the juices of a great many fruits, and it derives its name from its being obtained in great abundance from apples; it is composed of oxygen, hydrogen, and carbon.

MALICE, in Ethics and Law, a design formed for doing mischief to another. In murder, it is malice that constitutes the crime; termed, in an indictment for murder, *malitia præcogitata*, or *malice prepense*.

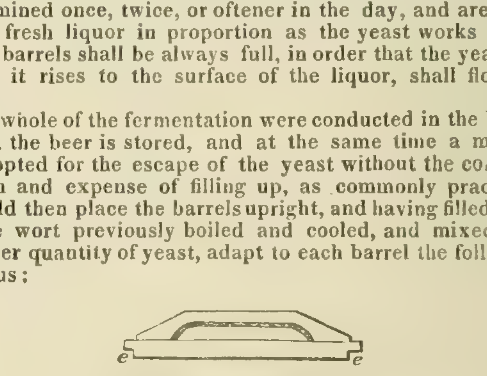
MALLEABLE, a property of metals, whereby they are capable of being extended under the hammer.

MALLET, a wooden hammer, used by artificers who work with a chisel, as sculptors, masons, and stone-cutters, whose mallets are commonly round; and by joiners, carpenters, &c. who work with square-headed mallets.

MALT, a term applied to grain which has been made to germinate artificially to a certain extent, after which the process is stopped by the application of heat. *See* Kiln.

The brightness of malt liquor depends much on the accuracy with which the yeast produced by fermentation is separated; and the usual method of effecting this is the following:—The wort, after being duly boiled with the proper quantity of hops, is transferred into coolers, and when its temperature has thereby been sufficiently lowered, it is removed to a large vessel, called the gyle-tun, either open or fitted with a moveable cover. Here, after being mixed with yeast, it undergoes the first fermentation. The half-fermented liquor is then put into barrels lying on their sides, with the bung-hole uppermost, out of which the yeast is continually discharging itself, till the fermentation has ceased or nearly so. During this time the barrels are examined once, twice, or oftener in the day, and are filled up with fresh liquor in proportion as the yeast works off, so that the barrels shall be always full, in order that the yeast, as soon as it rises to the surface of the liquor, shall flow off entirely.

If the whole of the fermentation were conducted in the barrel in which the beer is stored, and at the same time a method was adopted for the escape of the yeast without the constant attention and expense of filling up, as commonly practised, we should then place the barrels upright, and having filled them with the wort previously boiled and cooled, and mixed with the proper quantity of yeast, adapt to each barrel the following apparatus;



This apparatus consists of a tub *c c*, about the size of a peck measure, with a wooden cover *e e*, and having a vertical open pipe of pewter *b*, passing through the bottom; this pipe rises nearly to the top of the tub, and, almost as soon as it has passed through the bottom, expands into a broad flat margin, in order that it may be placed securely over the bung-hole of the barrel *a a*, with paper packing if required. Into the tub is pu liquor of the same kind as that with which the barrel is filled, except that it is not previously mixed with yeast; the quantity of the liquor (about one-twelfth) is such as will be rather more than sufficient to supply the loss in the barrel in consequence of the fermentation. As soon as this process begins, the yeast, rising to the surface of the liquor in the barrel, passes through the bung-hole into the pewter-pipe, and flows out of the upper end of it into the tub, the lighter particles in the state of froth floating on the surface of the liquor, and the heavier ones subsiding to the bottom. The vacuity occasioned by the separation of the yeast is continually supplied from the clear liquor in the tub, which flows in through the lateral hole *d*, in the vertical pipe.

By the adoption of the above described apparatus, we may save about one and a half per cent. in quantity, and have the quality of the liquor also considerably improved, besides avoiding the use of the gyle-tun, and the expense and loss of transferring the liquor therefrom to the barrels, and the loss of liquor in filling up according to the usual mode.

MALT *Liquor. Madame Gervais's Improved Brewing Apparatus.*—Presuming that the attention of the intelligent part of the public may be directed to the subject of brewing, by the notice of a new method of conducting part of that process, which appeared in several periodical publications, it becomes in some measure necessary to elucidate it. This cannot be effected better than by Dr. Birkbeck's judicious abridgment of the pamphlet describing Madame Gervais's improved brewing apparatus.

"I shall not at present," says Dr. Birkbeck, "advert to the conversion of barley into malt, or the artificial formation of saccharine matter by incipient vegetation, but shall begin with the infusion or decoction; that is to say, with the fluid obtained by immersing the bruised malt in hot water, or by exposing it to the action of that fluid when in a state of ebullition. It is next the object of the brewer to convert this fluid, holding mucilaginous and saccharine matter in solution, into wine, in the same manner as the *must*, or expressed juice of the grape, is rendered vinous. The curious process of fermentation is accordingly instituted, by adding a little yeast or ferment, by elevating the temperature, and by slight motion with free exposure to the atmosphere. But before the fluid to be fermented is supposed to be complete, so contradictory often are our opinions and practice, the *hop* must be added, that particular ingredient by which fermentation is to be arrested, or at least the subsequent formation of acetous acid be prevented. And although one practical brewer has shewn, more than twenty years ago, that much of the virtue, or, chemically speaking, of the essential oil, of the hop, is dissipated by heat, and I have pointed out to several persons engaged in brewing, the inconsistency of adding the hop before the first stage of fermentation is finished, yet little has been done in the way of improvement in these respects. To discover when the first stage of fermentation, the *vinous*, is complete, much attention is required: of the various methods proposed for determining the point, not one can be pronounced to be either sufficiently accurate or sufficiently easy of application; and accordingly it does happen, both in making beer and wine, that before they are enclosed in casks or bottles, so as to put an end to any further change, vinegar has begun to be formed; or the *alcohol*, the first product, has became converted into *acetic acid*, the second, and the article been rendered unfit for the end first intended. In reference to this difficulty, the new method of managing the fermentation possesses very great advantages. Requiring less heat at the commencement, and liberating less caloric in its progress, on account of the limited supply of oxygen gas, or rather, being left without any oxygen excepting what itself contains, fermentation will go on more slowly, and must be restricted to a certain point; so that it will become exceedingly difficult to produce any acetic acid. Besides, as the whole of the carbonic acid gas which is generated, must pass through the tube proceeding from the side of the cone, and the water, four inches in depth, in which it terminates, the cessation of the escape of air bubbles, which will be easily noticed, will mark unequivocally the conclusion of the fermentative change. Thus a greater quantity of alcohol will be formed, because, without any risk, the fermentation may be permitted to become complete, in the liquid wherein it occurs. Such part of the spirit too, as might fly off during the progress of this spontaneous internal change, will be condensed in the conical cover, kept cool by the water which surrounds it, and will be returned through the small pipe to the fluid below, together with the oily particles from the hop, evaporating and condensed in the same manner, provided the practice should still be continued, of introducing this ingredient before the fermentation is concluded. It will at once appear obvious that this plan is equally applicable to the manufacturing of wines, and has indeed, I understand, been employed successfully by Messrs. Bishops and Harrington, eminent British wine makers in the neighbourhood of Finsbury square. It will be not less obvious likewise, that the improvements now described are fitted for the service of the private brewer and wine maker, not less than for the very extensive manufactories, because to small vats, backs, or fermenting vessels, the conical cap, (with the air-tight condition of the apparatus,) can be applied most effectually. To distillers, this arrangement may become peculiarly serviceable, as it will enable them to allow fermentation to continue in the *wash*, as it is termed, which they prepare, without any danger of its becoming sour, to an extent, and with a degree of perfection as to the quantity of alchohol produced, which they might not otherwise be enabled to accomplish."

The pamphlet commences with the following appropriate and judicious remarks on the subject of vinous fermentation, and proceeds to describe the patent apparatus, and expatiate on its merits with candour and impartiality, as will be seen by the extracts we have made, for the purpose of communicating to the public, a clear and explicit description of the process.

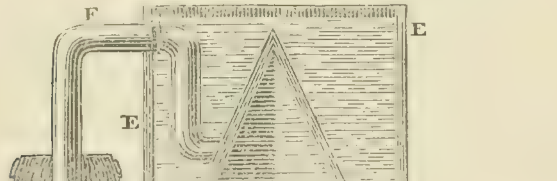
"There is scarcely a single production of the earth, which, when appropriated to the use of man, is not so modified or changed by various preparations, as to possess a different property from that it contained in its primitive state. Fruit and grain undergo decomposition, and a new recomposition, before he uses them as food; and until he applied art to the juice of the grapes, they were suffered to decay on the vines—but which the ingenuity of man converted into a pleasant, wholesome, and lasting beverage. In those climates where the only substitutes for wine were milk or water, the inhabitants are indebted to his invention for malt liquor, a beverage, which, although inferior to wine, is not destitute of some of those qualities that render it so great a desideratum.

"The phenomena by which these new properties are produced, is termed the vinous fermentation; it might, perhaps with more propriety, be called the alcoholic or spirituous fermentation, since it is a process by means of which all saccharine matters, whether they proceed from grapes, sugar-cane, or malt, are decomposed, and recombine to form alcohol. But however wrong this denomination may be, we shall make use of it in the following observations, as being well understood by all classes. A vinous fermentation, to be perfect, requires very exact proportions of mucilage and saccharine matter, so as to have the one just sufficient to destroy or attenuate the other; in which case the result would be, if the operation had been properly conducted, a mixture of alcohol and water, differently flavoured, according to the materials from which it was produced, as grapes, pears, apples, or malt and hops; but such accuracy in the proportions cannot be expected either from nature working at large, and every climate, soil, and situation, or from short-sighted man acting mechanically, and frequently in ignorance of what he is doing. A perfect fermentation, therefore, has been considered an object almost impossible to be obtained; and all we wish to shew is, that the errors of the mixture may be corrected, and the whole process improved, by good management.

"The common practice, until a few years back, has been to ferment in open vessels; and though it was a circumstance well known among chemists, that a certain portion of spirit and flavour escaped in the form of vapour during the process, yet no one had an idea that the condensatory system could be applied; as it appeared impossible to effect the fermentation in air-tight vessels, being unable to surmount the great difficulty which existed of keeping down and managing that enormous bulk of non-condensible gases, which are emitted during the decomposition of the saccharine matter, and which acquire greater expansive force by the gradual increase of heat. The idea, however, occurred to Madame Gervais, a proprietor of considerable vineyards near Montpellier, who has founded a system on the following principle; that what is termed the vinous fermentation is a mild, calm, and natural distillation; which, according to the usual acceptation of the word, has proved a correct system, since not a single drop of spirit is formed before it commences, nor after it is over. Having first laid down this ground-work, she proceeded to obtain an apparatus, that would operate in such a manner as to return into the vessel the spirit and flavour that was evolved from the fermenting gyle, and let out the non-condensible gases which might, by the increasing heat, acquire too great an expansive force, and burst the working tun; a short description of this apparatus will be a fresh proof that the greatest advantages are often derived from the most simple means. It consists of a vessel resembling the head of the ancient still, and constructed of such form as to be capable of being placed securely on the back or vat, in which the process of fermentation is to be carried on; the back or vat must be closed air-tight, with a hole in the top, communicating with that part of the apparatus called the cone or condenser. This cone is surrounded by a cylinder or reservoir, which is to be filled with cold water, so that the alcoholic vapour or steam evolved during the process, may be condensed as it comes in contact with the cold interior surface of the cone; and being thereby converted into liquid, trickles down the inside of the condenser, and through a long pipe is returned into the fermenting liquor.

"By the application of this apparatus, a considerable portion of alcohol, which has been hitherto suffered to escape in the form of vapour, along with the non-condensible gases, is condensed, and returned into the liquor; and the non-condensible gases are carried off by a pipe, which, proceeding from the interior lower part of the cone, and running up to the inside of the cylinder in the cold water, passes out through the side, and the end is immersed some depth below the surface of water contained in a separate vessel, permitting the gases to escape, but still under a certain degree of pressure, the object of which is, to confine the alcoholic steam and gas within the cone, and allow them a sufficient time to cool and condense."

*References to the Engraving.*—A A, closed vat in which the process of fermentation is carried on. B condensing cone, communicating immediately with the interior of the fermenting vat. C C, small channel extending round the interior base of the cone, for the purpose of receiving the condensed alcohol and essential oils, which are conducted down the small tube D into the vat. E E, reservoir for containing cold water surrounding the cone. F, exit-pipe communicating with the interior of the cone, its extremity being immersed some inches below the surface of the water in the small tub G, from which the non-condensible gases are permitted to escape into the atmosphere.



H, cock to draw of the water from the reservoir, E E.

"To persons in the least acquainted with chemical operations, it would be useless to dwell on the merits of this apparatus; they will at once see how beneficial it would prove to any liquid that has to undergo the vinous fermentation in any stage of its manufacture; but to those who are not so conversant in the principles and causes of these operations, we shall proceed to point them out.

"To obtain a good fermentation, as complete a decomposition of the must or wort, and as perfect a recomposition of alcohol as possible, are the great objects to be obtained. To acquire the former, three requisites are necessary; fluidity, heat, and motion: the latter, density, coolness, and tranquillity. Let us examine each of them separately: first, of fluidity. The specific gravity of the liquid most elligible to produce a good fermentation, is between 1.020, and 1·140; or eighteen for one hundred and thirty-two pounds, by Dicas's improved saccharometer made by Joseph Long, No. 20, Little Tower-street, London. Below eighteen pounds of real extract per barrel, the liquid is too thin to produce a proper fermentation, and above one hundred and thirty-two pounds it is too thick; but supposing the specific gravity of the must or wort to be correct, it may be carried beyond a proper dilation by too much heat, or congealed to too great a consistency by excessive cold; consequently, either a thunder storm or hard frost will derange the operation, and are equally injurious to fermentation. Any method therefore that will ensure an even temperature, must be of great importance: and such a method is obtained by applying the apparatus already described, since, by preventing the access of atmospheric air, the sudden changes of the external temperature can have no effect upon the fermenting gyle: and if it has been *pitched* at a proper heat, (which is between sixty-five and eighty,*) will proceed through its different stages as well during the hottest days of summer, as in the selected months of autumn and spring.

"With respect to motion, we are indebted to Monsieur Gay Lussac, an able French chemist, for a beautiful and important experiment, proving that must, possessed of all the requisites to produce a good fermentation, will not begin to ferment unless excited by a foreign agent. He placed the must in a close vessel, from which the atmospheric air had been exhausted, where it remained several days without giving any signs of fermentation, from which he concluded some power was wanting to break the union of its constituent principles; he therefore introduced a small quantity of oxygen, which immediately caused the must to ferment, evidently proving the necessity of a small portion of atmospheric air, (which contains oxygen,) to allow the fermentation to commence. But it at the same time proves, that, after performing that office, this great enemy to all fermented liquors may be dispensed with, without impeding the process; as the small quantity of oxygen introduced by Monsieur Gay Lussac, was soon absorbed by the carbon to form carbonic acid gas, and he found no occasion for any further supply.

"This discovery is of the greatest importance, since it enables us, without the least detriment or inconvenience to the process, to exclude the oxygen of the atmospheric air, which by constantly supplying the gyle with the principle that causes and promotes acidity, casts on it from the first that roughness and disagreeable flavour which spoil most of our common beverages. Here again the new apparatus proves of infinite benefit; for as soon as carbonic acid gas is evolved from the fermenting gyle, the atmospheric air being lighter, is driven out from the upper part of the working-tun, and as no air is permitted to enter afterwards, all the subsequent carbonic acid gas emitted diminishes the quantity of oxygen contained in the gyle by the oxygen uniting with the carbon as fast as it disunites from the saccharine matter during its decomposition, and thereby secures a soundness and peculiar mildness not to be procured by any other mode.

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* Fermentation will take place from forty-eight to one hundred and thirty-eight degrees.

"Having stated the necessary conditions for a complete decomposition of the saccharine matter, we shall proceed to notice those required for a good production of alcohol. The first already mentioned is a certain density, in order to allow the several principles which are disunited to recombine. It is doubtful whether such a combination will in any case take place, until the temperature of the gyle having attained its greatest heat, is afterwards cooled a few degrees: a fact confirming which is, that a portion of the liquid taken out when at its greatest heat, and tried by distillation, produced little or no spirit; but such refrigeration must not be effected too suddenly, as it might coagulate the yet undecomposed mucilage, and check its further action on the remaining saccharine matter; and by arresting that natural operation, which ought to be pursued a longer or shorter period according to the specific gravity of the fermentable matter, might produce that result termed ROPINESS, by holding in solution the coagulated mucilage.

"Here again the apparatus will be found of great service; for by frequently renewing the cold water in its reservoir, the internal temperature will gradually diminish by the heat of the gyle coming in contact with the cold interior of the cone; but in order to effect this, the tranquillity above mentioned is necessary, since the continual motion is caused by the oxygen soliciting new combinations with the carbon, and thereby constantly giving rise to a fresh supply of heat.

The writer then replies very satisfactorily to some objections which have been urged against the adoption of the patent apparatus, and shews it applicable, not only to the process of brewing malt liquors, but to the manufacture of wine, cider, perry, and vinegar. We shall now conclude with the following observations: The great advantages to be derived from this system are, excluding the atmospheric air, by which the acid principle which beer absorbs from the air during fermentation, is prevented entering into combination with it, and thereby insuring the brewer the certainty of making as sound beer during the hot weather as in winter: also the essential oil of the hops and the spirit, which escape on the old principle, are condensed, and returned immediately into the beer, thereby preserving an uniform flavour at all times. In addition to the preservation of flavour, strength, and soundness, and enabling the brewer to insure his beer, an increase of five per cent. is gained in the quantity, not only by condensing the alcoholic vapour, but by the yeast settling in a solid body, at the bottom of the tun, so that the beer may be drawn off clear to the last, and the yeast will be left in good condition for *pitching* with; likewise, the waste occasioned by the old system of cleansing will be prevented, and the beer will retain the fixed air in it, according to the resistance placed at the end of the escape-pipe, and a considerable saving of labour attend it.

Upon the new system, the fermentation may be brought to a perfect state at any period, according to the degree of heat made use of for fermentation; for as long as there remain any particles of saccharine matter in solution undecomposed, so long will the beer continue to increase in strength, arising from the decomposition of these particles, and which can only be promoted by their dilatation with a high fermentation heat; but when the whole of the saccharine matter is decomposed, and as perfect a fermentation as possible obtained, attenuation will be complete, and the beer will precipitate perfectly bright, there being no longer any carbonic acid gas generated to stir up the grosser particles of the fermented matter. Upon the old system of fermentation, beer can seldom be kept until it has attained a perfect state of attenuation; for as the decomposed particles of saccharine matter yield the basis of spirit, so also they yield the basis of acidity; and the beer having already absorbed too large a portion of that principle, an increase of attenuation is generally accompanied with a great increase of acidity. The flavour of beer, on the old system, depends upon the fermentation-heat, as the greater the heat in the tun, the larger is the quantity of essential oil evaporated, with a consequent loss of flavour; therefore to insure a good flavour, a low fermentation is necessary, and the lower the fermentation, the longer the saccharine matter is before it decomposes; whereas, on the new system, the whole flavour and strength are preserved, and any degree of heat may be employed to accelerate the fermentation, and bring the beer to an early attenuation.

MALT *Distillery*, the converting fermented liquors into a clear inflammable spirit, which is either sold for use in the common state of a proof strength, or rectified into spirits of wine, or made into compound cordial waters.

MALTA, KNIGHTS OF, or HOSPITALLERS *of St. John of Jerusalem*, a religious military order, whose residence was in the island of Malta. The order consisted of three estates, the knights, chaplains, and servants at arms. The government of the order was partly monarchical and partly aristocratical: the grand master being sovereign, none were admitted into this order but such as were of noble birth.

MALTHA, in Antiquity, a cement of which there were too sorts, native and factitious: one of the latter consisted of pitch, wax, plaster, and grease. Another kind, used by the Romans in their aqueducts, was made of lime slacked in wine, incorporated with melted pitch, and fresh figs. Native maltha, called also sea-wax, is a solid substance, found on the lake Baikal, in Siberia. It is white, melts when heated, and, on cooling, assumes the consistence of white cerate. It has also been found on the coast of Finland.

MAMALUKES, the line of a dynasty that reigned in Egypt. The Mamalukes were originally Turkish and Circassian slaves, bought of the Tartars by Melicsalah, to the number of a thousand, whom he bred up to arms, and raised some to the principal offices of the empire. They killed Sultan Moadam, whom they succeeded. The mamalukes were skilful horsemen. Their numbers were kept up by the purchase of fresh slaves, and so they continued for many centuries, ruling Egypt in the name of the Grand Signior of Turkey, until the conquest of Egypt by Buonaparte. They then retreated into Nubia, and in 1811 they were decoyed into the power of the Turkish pacha, and slain.

MAMMA, from *Mamma*, the fond word for Mother. This word is said to be found for the compellation (word of salutation) of Mother, in most languages, and is therefore supposed to be the first syllables that a child pronounces.

MAMMALIA, is properly a branch of Natural History, and indicates the first class of the animal kingdom, containing those animals which suckle their young. Several scientific and ingenious arrangements of the animal kingdom into classes, orders, genera, and species, have been successively adopted; that of Monsieur Cuvier, the French anatomist, possesses a high degree of merit. But though his arrangement evinces great anatomical precision, and the highest philosophical knowledge of animals, yet, to a general reader, it has a complicated and forbidding appearance, and is less attractive than the more simple arrangement of Linnæus, which divides the animal kingdom into six classes; *mammalia, aves, amphibia, pisces, insecta, vermes:* or, such as suckle their young; birds; creatures living equally on land or in the water; fishes; insects; and worms. Each of these classes is subdivided into orders, genera, species, and varieties of those species. These classes are thus arranged for conciseness:

CLASSES.

|  |  |  |  |  |
|---|---|---|---|---|
| Body. | With vertebræ.... | Hot blood —— | Viviparous.... | 1. Mammalia. |
|  |  |  | Oviparous .... | 2. Birds. |
|  |  | Cold red blood.. | With lungs .... | 3. Amphibia. |
|  |  |  | With gills..... | 4. Fishes. |
|  | Without vertebræ.. | Cold white blood | Have antennæ | 5. Insects. |
|  |  |  | Have tentacula | 6. Worms. |

The class mammalia, consists of such animals as produce living offspring, and nourish their young with milk supplied from their own bodies; it comprises both the quadrupeds and whales. Their head is the seat of the principal organs of sense, the mouth, the nose, the eyes, and ears.

*Touching* or *feeling*. The outside of the skin is covered with a thin pellicle, called the *epidermis*, cuticle, or scarf-skin. Under the cuticle, is the *rete mucosum*. In negroes, this substance is black; in Europeans, white, brown, or yellow. The *cutis vera*, or the skin, is a substance made up of fibres closely connected with each other, and running in various directions, being composed of the extremities of numerous vessels and nerves. The *papillæ* of the fingers or inside of the hand, may become erect or elevated, and being gently pressed against a tangible body, receive an impression which is conveyed to the brain, and is called *touch.* Spiders, flies, and ants, have this sense in the greatest perfection.

*Tasting.* The tongue is covered with two membranes; the external is thick and rugged, especially in quadrupeds; the internal membrane is thin and soft, and upon it appear *papillæ*, or small elevations, like the tops of the small horns of snails. These papillæ are composed of the extremities of the nerves of the tongue, and piercing the external membrane, are constantly affected by those qualities in bodies, which have their tastes excited in the mind by means of these nervous papillæ, which are the immediate organ of tasting. This organ bears a strong analogy to the sense of touch.

*Hearing.* The undulations of the atmosphere, excited by the vibrations of sonorous bodies, are collected in the external ear and auditory passage, as in the hearing trumpet, and are conveyed to the *membrana tympani*, or drum, which they cause to vibrate. The effect is transmitted through the small bones, to the watery fluid that fills the internal ear, in which the delicate filaments of the auditory nerve float, and by this nerve the sensation is conveyed to the brain. But it is remarkable how nicely is the ear constructed in various animals; in man its position and form are admirably contrived for his erect posture; in quadrupeds we see it large, susceptible of easy motion, as when the horse lays his ears back or points them forward; in the mole it is lodged deep in the head. The structure of the ear is also remarkable, for it is so contrived and tunnelled that it may not only catch sounds, but prevent the more furious undulations of the air from injuring the interior membrane. And to prevent insects from lodging within its cavity, as well as to keep it moist and in tune, it is supplied with a bitter nauseous wax.

*Smelling.* The cavity of the nose is divided into two parts, called the *nostrils*, by a partition, of which the upper part is bony, and the lower cartilaginous. The upper part of the cavity is covered with a thick glandulous membrane, above which the *olfactory nerve* is finely branched out and spread over the membrane of the spongy bones of the nose, and other sinuous cavities of the nostrils. The odorous effluvia of bodies being disseminated in the atmosphere, the latter fluid passes through the nose in respiration, and the odorous particles are thus brought into contact with the fibres of the nerves, which, by their communication with the brain, excite in the mind the sense of smell.

*Seeing.* The eye is the organ of sight, and its sensations are of the utmost importance to the well-being and safety of animals. The eye is composed of three *coats*, covering one another, and enclosing different substances called *humours.* The three coats are the *sclerotica*, the *choroides*, and the *retina.* The three humours are the *aqueous*, the *crystalline*, and the *vitreous.* Objects are seen by means of their images being painted on the retina of the eye, in an inverted position, though they appear erect. When the crystalline humour loses its transparency, the disorder is called a *cataract*, and the remedy applied is called *couching*, which is performed by thrusting a fine awl through the coats of the eye, and pushing the crystalline to the bottom of the eye, where it will remain, and its deficiency may be supplied with a convex lens. When the defect of vision is in the optic nerve, it is called a *gutta serena*, and the disorder is generally incurable. The external parts of the eye are, the eye-brows, the eye-lids, and eye-lashes. The eye-brows defend the eyes from too strong a light, and serve to turn away substances which might otherwise fall into the eye. The eye-lids act as curtains, by covering and protecting the eyes during sleep; and in our waking hours they diffuse a fluid over the eye which renders it better adapted to transmit the rays of light. The eye-lashes guard the organ from danger, and protect it from dust and insects floating or flying in the atmosphere.

The mouth contains the teeth, which are inserted into two moveable bones, the upper and under jaw. The front or cutting teeth are in general wedge-shaped, and so placed that in action their sharp edges are brought into contact. Next to these are situated the canine teeth or tusks, which are in general longer than the front teeth, conical, and pointed. The teeth in the back of the jaw, and between which the food is chewed or masticated, are called grinders. In such animals as subsist on vegetable food, the latter are somewhat flattened at the top; but in the carnivorous tribes, their upper surfaces are furnished with sharp and conically pointed protuberances. It is principally from the numbers, form, and disposition of the teeth, that Linnæus has arranged the various genera or tribes of quadrupeds.

The class Mammalia has been distributed into seven orders, founded for the most part on the number and arrangement of the teeth; and on the form and construction of the feet, or of those parts in the seals, whales, and other animals, which supply the place of feet.

*Orders of Mammalia.*—1. Primates, have the upper front teeth generally four in number, wedge-shaped, and parallel; and two teats situated on the breast, as apes and monkeys. 2. Bruta, have no front teeth in either jaw; and the feet armed with strong hoof-like nails, as the elephant. 3. Feræ, have in general six front teeth in each jaw; a single canine tooth on each side in both jaws; and the grinders with conic projections, as the dogs and cats. 4. Glires, have two long projecting front teeth in each jaw, which stand close together; and no canine teeth in either jaw, as the rats and mice. 5. Pecora, have no front teeth in the upper jaw; six or eight in the lower jaw, situated at a considerable distance from the grinders; and the feet with hoofs, as the cattle and sheep. 6. Belluæ, have blunt wedge-shaped front teeth in both jaws; and the feet with hoofs, as the horses. 7. Cetæ, have spiracles, or breathing holes, on the head; fins instead of fore feet; and a tail flattened horizontally, instead of hind feet. This order consists of the narwals, whales, cachalots, and dolphins.

**MAMMARY** Gland, in Anatomy, is a glandular substance situated in the breast, and secreting the milk.

**MAN.** The varieties of the human species, as arranged by Blumenbach, are five in number:—1. Caucasian variety, which includes the Europeans, (excepting the Laplanders, and the rest of the Finnish race,) the western Asiatics, as far as the river Ob, the Caspian sea, and the Ganges, and the northern Africans. 2. Mongolian variety, which includes the rest of the Asiatics, (excepting the Malays;) the Finnish races of the colder parts of Europe, as the Laplanders, &c. and the tribes of Esquimaux; extending over the northern parts of America from Bhering's Strait to the extremity of Greenland. 3. Ethiopian variety, contains the remaining Africans, besides those classed in the first variety. 4. American variety. To this belong all the Americans, except the Esquimaux. 5. Malay variety, includes the inhabitants of Malacca, of the South Sea, Ladrone, Philippine, Molucca, and Sunda islands. Each variety is distinguished by the colour of the hair, and some striking peculiarities of feature. We shall now briefly describe the external and internal structure of the human body, and the five senses.

*External Structure of the Human Body.*—Among all the visible parts of the body, the head holds the most distinguished place; both because of its beauty, and because it contains the principles of sense and motion. All the sentiments and passions of the soul are painted on the face, which is the most beautiful part of man; and where the principal organs of sense are found, through the medium of which we receive impressions from external objects. The different motions of the lips, and those of the tongue, whether it touch the palate or the teeth, serve for the articulation of words, and the different inflexions of sound. By the teeth we can cut or grind our food; and the saliva, so necessary to digestion, is furnished by a great number of glands, which are contained in the mouth. The head is placed upon the neck, and turns as on a pivot, to any side we please. After the neck comes the shoulders, so formed that they are able to bear heavy loads. To the shoulders the arms are joined; and to those, the hands, which are so constructed as to perform an infinity of motions; to touch, take, raise up, draw back, repel, &c. the joints and bones serving to support and facilitate these motions. The breast includes and defends the heart and the lungs; and for this purpose it is composed of strong and hard ribs and bones. The diaphragm separates the breast and belly, which contains the stomach, liver, spleen, and intestines. All this mass rests upon the hips, thighs, and legs, which, like the arms, have different articulations favourable to motion and rest. The feet sustain the whole, and the toes also contribute to it, because they serve to fix the feet more firmly upon the ground. The skin and flesh cover the whole body. The hair and the down, which are found in different parts, protect them from the injurious effects of cold. The bones, the most compact and solid parts of the body, serve for the attachment and support of all other parts. Bones are firm, hard, and perfectly insensible, they are divided into the long, the cylindrical, and the flat. There are 248 separate bones in the human body; these, connected with wires, are sometimes made up into an artificial skeleton. There are eight separate bones in the skull, that serves as a vault for the brain. The vertebræ of the neck, so called from the ease with which they move, are separated from one another by an elastic substance. They support the head, which by their means is readily moved up and down, and turned round on either side as far as is necessary, like a piece of mechanism in a ball and socket; to the breast bone, the seven true and five false ribs are fastened: the spine extends from the skull to the end of the loins, and serves to lodge and defend the spinal marrow: the pelvis supports the abdomen, and the thorax reaches from the neck to the end of the breast bone, serving as a chest or place of safety for the heart, lungs, &c.

*The Muscles, Arteries, Veins, and Circulation of the Blood.*—The muscles constituting the flesh are susceptible of contraction and relaxation, and, with the help of the tendons, are the instruments of animal motion. The muscles are either *voluntary* or *involuntary*. The motions of the former are subject to the will, as in the case of the arms, legs, &c. The heart, which is a hollow muscle, and the stomach, intestines, &c. act upon their contents by means of muscular fibres, called involuntary muscles, because their motions depend not on the will. Each large muscle consists of two parts, *viz.* the belly, which is the active part, and its cord-like extremities called tendons, which fasten the muscle to the bones, and perform their action by contracting both ends towards the centre. The red colour which distinguishes the muscular parts of animals is owing to the number of blood-vessels dispersed through their substance. The nerves, long, white, medullary cords, originate in the brain and spinal marrow, and serve for sensation. *Sensibility*, therefore, depends on the nerves; *motion*, on the muscles. The nerves conduce to all the enjoyments and sufferings of life, and to the intellectual faculties of man: the muscles are the chief support of animal life, and the source of all the bodily powers. The heart is the principal organ of life; it contains four cavities for receiving the blood, and giving it a fresh impulse through the arteries. The arteries originate in the heart, and through them the blood is carried from the heart to every part of the body, for the preservation of life, generation of heat, nutrition, and the secretion of the different fluids. The pulse, felt at the wrist, temples, and various parts of the body, is occasioned by the reciprocal action of the heart and arteries, when the blood is driven from the heart into the arteries to be distributed through the whole body. The arteries terminate in small microscopic veins, which bring back the blood from the extremities to the heart. The veins originate at the extremities of the arteries: they continually increase in size as they approach the heart: they do not pulsate, but the blood they receive from the arteries, they carry back with a slow motion, and it is prevented from returning by innumerable valves. The double circulation of the blood is this: one motion is from the heart to the lungs, for the purpose of receiving oxygen from the air; the other motion is over all the parts of the body, to give out its nutritive and vital properties to the whole machine.

*The Brain and Nerves.*—The brain, a small pulpy mass of a whitish colour, occupies all that cavity formed by the bones of the skull. The spinal marrow, a continuation of the brain, passes out of an opening in the skull, and runs down the canal of the back-bone, giving out nerves in its passage. The nerves run out in pairs, separate and spread over the whole body. The brain and nerves constitute entire the organs of feeling and sensation, the other parts of the body being incapable of feeling. Excitement to action, produced by the will, proceeds from the brain and spinal marrow, through the medium of the nerves. The nerves are therefore the organs, the brain the receptacle, of all our sensations, and the source of all our ideas.

*The Stomach, Liver, Digestion, &c.*—The stomach, shaped like a bag, is the grand receptacle for the food, where it is retained until it is changed by *digestion*. The stomach has two openings, one called the œsophagus, through which the food passes into it; the other, intended to carry away the digested substance, is called the intestinal canal. The chief agent in digestion is the *gastric juice*; by the muscular nature of the stomach, the food when properly digested is propelled through the intestinal canal into the intestine, a membranous tube, about five times the length of the person in which it is contained. Food is called *chyme*, in which state it enters the intestine, where it undergoes another change, and the *chyle*, a milk-like substance, is separated from it. Chyle is that substance from which the blood is formed, it is absorbed by the mouths of the lacteal vessels, every where distributed in the intestines, while the feculent parts of the chyme and the bile are driven into the large intestine, by which it is expelled from the body. The liver is formed for the secretion or separation of the bile from the blood, which passes into the *ductus hepaticus*, and thence into the gall-bladder, where it is kept till it is wanted to mix in the intestine. The chief uses of the bile are, to extricate the chyle from the chyme; and to excite the peristaltic motion of the bowels. The lacteals convey the chyle from the intestine into the jugular vein, that empties itself into the heart. The kidneys are two glandular substances which drain the system of its redundant water; for this purpose a considerable portion of the blood is perpetually passing into each kidney, where it leaves its superfluous water, and then returns into the circulation by means of a particular vein. The water thus strained from the blood is carried by canals into the bladder, into which it passes through its two coats, which answer the purpose of a valve to prevent regurgitation.

**MAN.** By this word, used in the sea language, a ship is frequently understood as a Man of war, a Merchantman, a Guineaman, an East Indiaman, a Greenlandman, &c. in all which instances the word ship is implied. *To Man*, is to place men sufficient for any particular exercise at the proper station: as, *Man the Capstan*, that is, place the men to the bars in readiness to heave. *Man the Top-sail Sheets*, that is, let the men lay hold of, and be ready to pull up, the top-sail sheets. *To Man the Ship*, is to range the people on the yards and rigging, in readiness to give three cheers, as a salute. *To Man the Yards*, to send a sufficient number of men upon the yards to reef or furl the sails. *To Man a Prize*, to send a proper number of men on board to navigate her.

**MANCIPLE**, *(Manceps,)* a clerk of the kitchen, or caterer. An officer in the inner temple was anciently so called, who is now the steward there; of whom Chaucer, the ancient English poet, sometime a student of that house, thus writes:

> A manciple there was within the temple,
> Of which all caterers might take ensample.

This officer still remains in colleges in the universities.

**MANDAMUS**, in Law, a writ that issues out of the Court of King's Bench, sent to a corporation, commanding them to admit or restore a person to his office. This writ also lies where justices of the peace refuse to admit a person to take the oaths in order to qualify himself for enjoying any post or office; or where a bishop or archdeacon refuses to grant a probate of a will, to admit an executor to prove it, or to swear a churchwarden, &c.

**MANDRAKE**, *See* ATROPA.

**MANDREL**, a kind of wooden pulley, making a member of the turner's lathe. Of these there are several kinds; as, Flat Mandrels, which have three or more little pegs or points near the verge, and are used for turning flat boards on. Pin Mandrels, which have a long wooden shank to fit into a round hole made in the work to be turned. Hollow Mandrels, which are hollow of themselves, and used for turning hollow work. Screw Mandrels, for turning screws, &c.

**MANE**, the hair hanging down from a horse's neck, which should be long, thin, and fine; and, if frizzled, so much the better.

MANEGE, or MANAGE, the exercise of riding the great horse; or the ground set apart for that purpose; which is sometimes covered, for continuing the exercise in bad weather; and sometimes open, in order to give more liberty and freedom both to the horseman and horse. *See* HORSEMANSHIP. The word is borrowed from the French *manage*, and that from the Italian *maneggio;* or, as some will have it, *à manu agendo,* "acting with the hand."

MANGANESE, a metal which is not only an object of interest in the speculations of the experimental chemist: but of the utmost use in manufactures, from its being employed to furnish the chlorine gas, which is so effectual in bleaching. It is a metal of a dull whitish colour when broken, but which soon grows dark by oxidation from the action of the air. It is hard, brittle, though not pulverizable, and rough in its fracture; so difficultly fusible, that no heat yet exhibited has caused it to run into masses of any considerable magnitude. Its sp. gr. is 8·0. When broken in pieces, it falls into a powder by spontaneous oxidation. Concentrated sulphuric acid attacks manganese, at the same time that hydrogen gas is disengaged. The ore of manganese, which is known in Derbyshire by the name of *black wadd*, is remarkable for its spontaneous inflammation with oil. It is of a dark brown colour, of a friable earthy appearance, partly in powder, and partly in lumps. If half a pound of this be dried before a fire, and afterwards suffered to cool for about an hour, and it be then loosely mixed or kneaded with two ounces of linseed oil; the whole, in something more than half an hour, becomes gradually hot, and at length bursts into flame. This effect wants explanation. It seems, in some measure, to resemble the inflammation of oils by the nitric acid. Manganese was used chiefly by glass makers and potters; but the important discovery of chlorine has greatly extended its utility.

MANGER, in sea language, a small space extending athwart the deck of a ship of war immediately within the hawse-holes, and separated on the after-part from the other part of the deck by the manger board, a strong bulk-head, built as high as, and serving to stop the water which sometimes rushes in at the hawse-holes, and would otherwise run aft in great streams on the deck; the water, thus stopped, is again returned into the sea through the scuppers.

MANGLE, a valuable domestic machine, employed for the purpose of smoothing such linen as cannot be conveniently ironed. Various patents have been granted for improvements in this machine: but, as many of them are too complicated to be understood without very tedious details, we have represented an improved mangle contrived by Mr. Jee, of Rotherham. (See the Plate.)

A, fig. 11, points out the great wheel, which, in machines of a full size, is 15 inches in diameter. B, the arbor, on which the nut, C, is fixed. D, the handle of the winch. E, the crank, 21 inches in length. F, the rod of the crank. G G, represents the hollow studs, by which the ends of the bed are lifted up. H H, the levers. I I I I, the four pulleys fixed on the moveable bed K. L L, the ends of the rollers. Fig. 12, represents a front view of one of the hollow studs G, to shew its form when standing at the end of the bed; and into which the levers enter alternately, as often as it becomes necessary to elevate the bed, in order to put in, or take out, the rollers.

This mangle is so constructed, that the handle requires to be turned one way only, in consequence of which the machine moves with greater facility, and with incomparably less injury to the linen, than by varying the turnings, and in a manner cutting the different folds. Besides, it possesses the great advantage, that a woman and one boy are sufficient to work it, and can perform as much labour in the same period of time as three or four persons with mangles of the common construction.

*Morris's Patent* MANGLE, being compact and moderately simple, may here be described. This mangle is constituted of four horizontal rollers, the pivots of which play on suitable supports in a stout wooden frame put together with bed-screws. To avoid circumlocution, we shall denote these four rollers by the letters A, B, C, D, (see the Plate.) The two rollers A and B, whose axles bear on brass or iron, let into the wooden frame, are posted side by side, but not so as to touch. C is a moveable roller, about which the linen or cloth to be mangled is rolled, and is then placed upon the rollers A and B, so as to lie in part between them. The axis of the fourth roller D works in pieces of brass or iron, which slide between two other pieces of metal, so that this roller D admits of elevation and depression, by means of a lever working upon a horizontal shaft (at the top of the frame) and chains of suspension. The pieces of metal in which the axle of the roller D runs have long vertical pieces of iron attached to them, so as to reach below all the rollers; and to hooks at the lower extremities of these irons are hung chains carrying either a rectangular platform loaded with weights, or a rectangular box containing stones or other ponderous matter. In using this machine, the lever is pressed down and fastened by a hook; by this process the roller D, and platform below all, is elevated; then the linen to be smoothed is wrapped about the roller C, which is next laid to rest between the rollers A and B. The lever is then freed from the hook which kept it down, and the action of the ponderous matter on the platform brings the roller D into contact with the roller C: in this state a rotatory motion is applied to all the rollers by means of a winch fixed to the axle of D; and in a short time the pressure of the roller C, against A, B, and D, will give the requisite smoothness to the linen.

The patentee says, this machine will act best with a wheel on the axis of each of the cylinders A and B, and a pinion between them, with a fly-wheel on the axle of the pinion, to which motion being given, all inequalities of pressure will be conquered with great ease. This machine is not confined to mangling only, but may be used with success as a copper-plate printing press, a letter-copying machine, &c.

*An Improved* MANGLE, *by Elisha Pechey.*—In this machine, a regular alternating motion is carried on by a power continued in one direction. The novelty in this mangle is, the contrivance for obtaining the alternate forward and backward motion of the box, and consequently of the rollers, by continually turning the winch in the same direction. More than one mode of obtaining this object is already before the public, but the simplicity, ingenuity, and efficacy of the arrangement adopted by Mr. Pechey for this purpose, will be apparent from the following description:—

Figure 1 exhibits a plan or view of the upper side of the mangle. Fig. 2 is an end view. Fig 3 is a side view; the bottom parts of the frame being represented as broken off, so as to reduce it within the plate; but the whole height is seen in fig. 2. The same letters of reference apply to the same parts in each figure. Fig. 4 is a section of a double rack, *a a* and *b b*, together with the plummer blocks or guides *c c*, (which support and guide the rack or axis *d d*,) being cut by a plane in the direction of, and perpendicular to, the axis. Fig. 5 is a similar section, shewing the rack in another situation, as will be hereafter described. Fig. 6 is a view of part of the shaft *d d*, shewing the two journals *e e*, which turn and are supported in the plummer blocks, and also the pinion *f* of three teeth, formed in the middle part of the shaft which works into the racks. Fig. 7 is a section of the plummer block, cut in the direction of the dotted line *g g*, fig. 4, and of the pinion *f*, together with a side view of one end of the racks *a a* and *b b*. Figs 4, 5, 6, and 7, are drawn double the size of the former.

A A, &c. is the frame of the mangle, B B the moveable box which contains heavy weights, and C C two rollers, which are all made in a similar way to other mangles.

On the upper side of the frame A A, &c. are fixed head stocks D D, which are fixed and kept perpendicular to each other by an iron bar *h h;* on the upper side of the bar are fixed the plummer blocks *c c;* the upper and lower parts of the plummer blocks have projecting pieces *i i* and *j j*, which support and guide the double rack, see figs. 4 and 5. *a a* and *b b* is the double rack, which is fixed parallel to the box B B, by means of two perpendicular studs *k k;* the studs pass loosely through loops in each end of the racks, so that the rack is at liberty to move up and down, being at the same time prevented from sliding off by the pins *l l;* each end of the rack is supported by two spiral springs *m m* fixed on the upper side of the box: the ends of these springs pass through small holes in the ends of the rack, and tend to support it in a middle situation, such a position as that the pinion *f*, fig. 7, shall be in gear with the

Fig. 2.

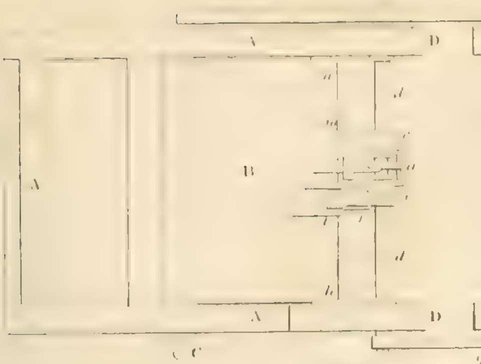


Fig. 1.

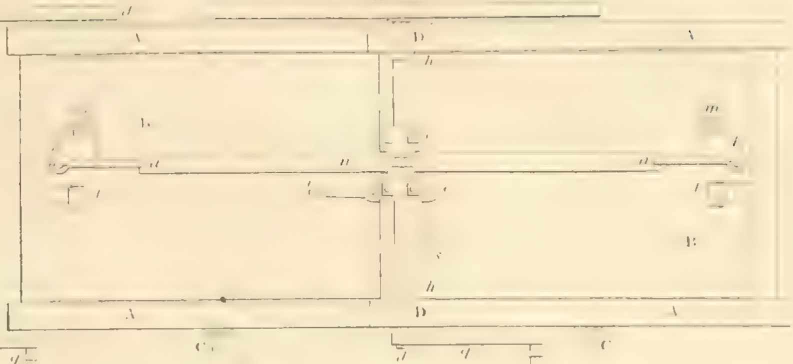


Fig. 4.

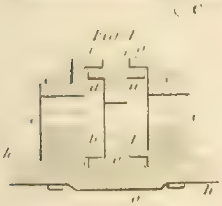
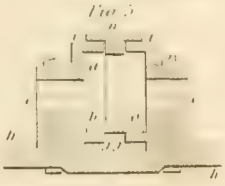


Fig. 5.



Pracing's — Fig. 3. — Mangle

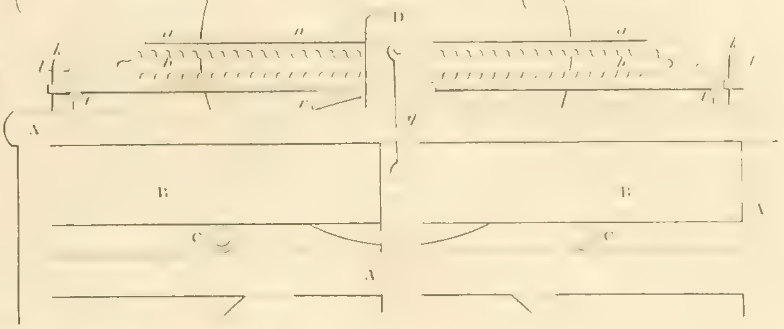


Fig. 6.

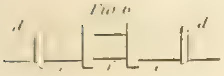
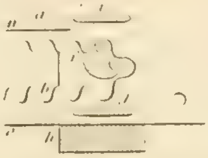


Fig. 7.



Mangle — Fig. 8.

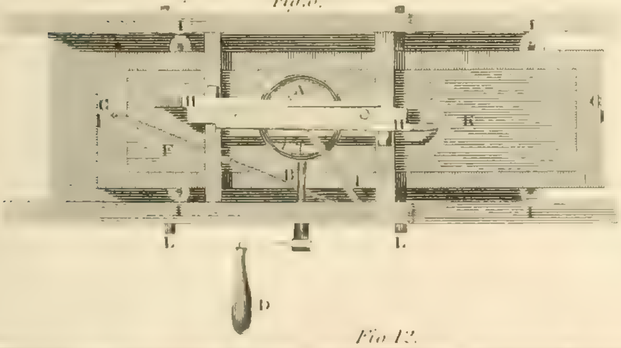
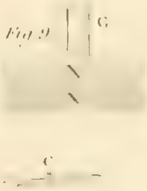


Fig. 9.



Rustalls Family Mill

Fig. 10.

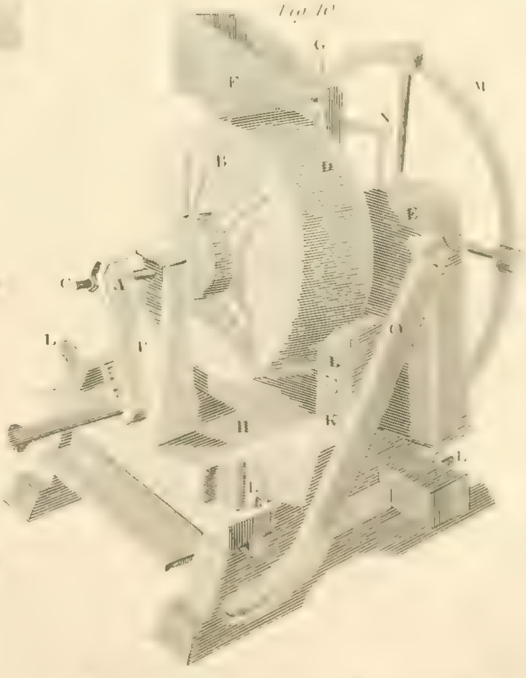


Fig. 12.

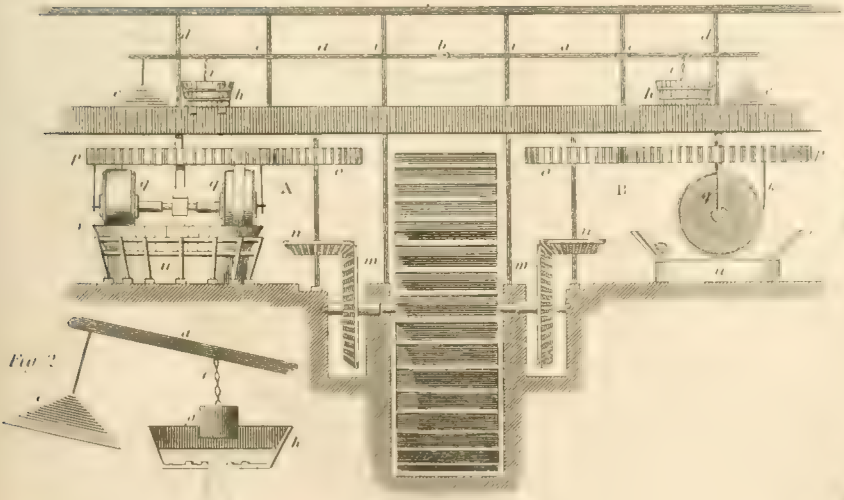
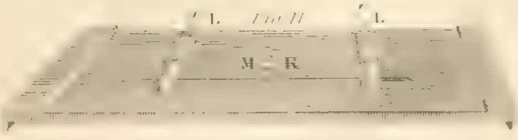


Fig. 11.



Monk's Improved Gunpowder Mill

upper bar of the rack. The double rack consists of a flat bar of iron, having teeth formed in the internal part of it, (as shewn in figs. 3 and 7,) and also two fins, or ribs, *n* and *o*, fixed to the upper and lower edges of it, and projecting on each side of the rack. The use of these fins is to support the rack in the two situations, as shewn in figs. 4 and 5. *d d* is a shaft or axis, which is supported by the head stocks D D, and by the plummer blocks *e e*, having a fly-wheel *p* fixed to one end of it, and a winch *q* to the other, by which means the machine is put in motion: in the middle part of the shaft *d d* is the pinion *f*, which works in the teeth of the rack; in figs. 3 and 7, the pinion is represented working in the rack *a a*: now, suppose a rotatory motion be given to the winch, the pinion will cause the rack, together with the box, &c. to move in a longitudinal direction till the end of the rack has arrived at the pinion, when it will be seen, by referring to fig. 7, that the rack cannot pass any further in that direction. By continuing to turn the winch in the same direction as at first, it is evident that the next tooth of the pinion will take into the gap in the end of the rack, and thus cause the rack to slide up the stand *k*, till the fins on each side of the rack are raised above the projecting pieces *i i* and *j j* of the plummer blocks; the next succeeding tooth will act in the first gap of the lower rack *b b*, which will cause the rack, together with the box, &c. to move in the contrary direction till the other end of the rack has arrived at the pinion, when a tooth of the pinion will act in the gap in that end, and cause the rack to slide down the stud *k*, when the next tooth of the pinion will act in the first gap of the upper rack, and cause the rack to move in the direction first mentioned, and by continuing the motion of the winch in the same direction, an alternate motion of the rack box, &c. is effected.

To replace or change the rollers C C, one of the arms *r* or *s* must be turned on the joint by which it is fastened to the plummer block in a direction parallel to the side of the rack, as shewn at *r* in fig. 1.

The arm forms an inclined plane, as shewn at *r*, fig. 3, so that when the end of the box B B approaches towards the centre of the frame, the friction roller *t* (one of which is fixed to each end of the box) passes up the arm or inclined plain *r*, and raises the end of the box, so that the roller C may be removed. A new species of mangle, on the principle of the parallel ruler, has been invented, and is called the *perpendicular mangle;* but it seems greatly inferior to the last mentioned machine of this name.

MANICHEES, in Church History, a sect of Christian heretics in the third century, the followers of Manes, who taught that there were two principles, or gods, co-eternal and independent on each other; the one the author of all evil, and the other of all good.

MANIFEST, an inventory of the whole cargo of a merchant ship.

MANIFESTO, a public declaration made by a prince in writing, shewing his intentions to begin a war or other enterprise, with the motives that induce him to it, and the reasons on which he founds his rights and pretensions.

MANILLE, in Commerce, a large brass ring in the form of a bracelet, either plain or engraven, flat or round. Manilles are among the commodities which the Europeans carry to the coast of Africa, and exchange with the natives for slaves. These people wear them as ornaments on the small of the leg, and on the thick part of the arm above the elbow. The great men wear manilles of gold and silver; but these are made in the country by the natives themselves.

MANIPULUS, in Roman Antiquity, a body of infantry consisting of 200 men.

MANIS, in Natural History, a genus of mammalia, of the order bruta. These animals resemble the ant-eater, and feed like that creature by protruding their tongues into the nests of various species of insects, and retracting them with inconceivable suddenness, with their prey attached to the tip. There are three species; the chief of which, the long-tailed manis, has a tail more than twice the length of its body, and is often in the whole seen five feet long. Its colour is a dark brown, with a tinge of yellow, and it displays a very brilliant gloss. It is perfectly covered, except on the belly, with large scales resembling the substance of horn. It is a native of India. The short-tailed manis, much thicker and shorter than the former, is covered with scales still thicker and stronger. It is found in many parts of India and Africa. It moves with great slowness, but on imminent danger of attack, rolls itself up with the compactness of a ball, and defies, in this state, the attempts even of some of the larger beasts of prey. It frequents marshy and woody places, and lives almost entirely on insects, particularly on ants.

MANNA. Several vegetables afford manna, but the ash, the larch, and the alhagi, afford it in the largest quantities. The ash which affords manna grows naturally in all temperate climates; but Calabria and Sicily are the most natural countries to this tree. The manna flows naturally from this tree, and attaches itself to its sides in the form of white transparent drops, but the extraction of this juice is facilitated by incisions made in the tree during summer. Its smell is strong, and its taste sweetish and slightly nauseous; if exposed on hot coals, it swells up, takes fire, and leaves a light bulky coal. Water totally dissolves it, whether hot or cold. If it be boiled with lime, clarified with white of egg, and concentrated by evaporation, it affords crystals of sugar. Manna affords by distillation, water, acid, oil, and ammonia; its coal affords fixed alkali. This substance forms the basis of many purgative medicines.

MANNER, in Painting, a habitude that a man acquires in the three principal parts of painting, the management of colours, lights, and shadows; which is either good or bad according as the painter has practised more or less after the truth, with judgment and study. But the best painter is he who has no manner at all. The good or bad choice he makes is called *goute*.

MANNERS, the plural noun, has various significations; as, the general way of life, the morals, or the habits, of any person or people; also ceremonious behaviour, or studied civility. *See* the next article.

*Good* MANNERS, according to Swift, is the art of making those people easy with whom we converse. Whoever makes the fewest persons uneasy, is the best bred man in the company. As the best law is founded upon reason, so are the best manners. And as some lawyers have introduced unreasonable things into common law; so, likewise, many teachers have introduced absurd things into common good manners.

MANŒUVRE, in a military sense, consists solely in distributing equal motion to every part of a body of troops, to enable the whole to form, or change their position, in the most expeditious and best method, to answer the purposes required of a battalion, brigade, or line of cavalry, artillery, or infantry. It has always been lamented, that men have been brought on service without being informed of the uses of the different manœuvres they have been practising; and, having no ideas of any thing but the uniformity of the parade, instantly fall into disorder and confusion when they lose the step, or see a deviation from the straight lines they have been accustomed to at exercise. It is a pity to see so much attention given to show, and so little to instruct the troops in what may be of use to them in real service. No manœuvre should be executed in presence of the enemy, unless protected by some division of the troops.

MANOMETER, an instrument, intended to measure the rarefaction and condensation of elastic fluids in confined circumstances, whether occasioned by variation of temperature or by actual destruction, or generation of portions of elastic fluid. It is sometimes called *manoscope.* Mr. Boyle's *statical barometer* was an instrument of this kind; it consisted of a bubble of thin glass, hermetically sealed, about the size of an orange, which being counterpoised when the air was in a mean state of density, by means of a nice pair of scales, sunk when the atmosphere became lighter, and rose as it grew heavier. This instrument would evidently indicate the changes of density in the atmosphere, but it leaves us uncertain as to the cause, whether it is from the change of its own weight, or of its temperature, or of both. The manometer constructed by Mr. Ramsden, and used by Captain Phipps, in his voyage to the North Pole, was composed of a tube of a small bore, with a ball at the end; the barometer being at 29.7, a small quantity of quicksilver was put into the tube, to take off the communication between the external air, and that confined in the ball, and the part of the tube below this quicksilver. A scale is placed on the side of the tube, which marks the degrees of dilatation arising from the increase of heat in this state of the weight of the air, and has the same graduation as that of Fahrenheit's thermometer, the point of freezing being marked 32. In this state, therefore, it will shew the degrees of heat in the same manner as a thermometer. But if the air becomes lighter, the bubble enclosed in the ball, being less compressed, will dilate itself, and take up a space as much larger as the compressing force is less; therefore the changes arising from the increase of heat will be proportionably larger, and the instrument will shew the differences in the density of the air arising from the changes in its weight and heat. Mr. Ramsden found, that a heat equal to that of boiling water, increased the magnitude of the air from what it was at the freezing point $\frac{404}{1000}$ of the whole. Hence it follows, that the ball and part of the tube below the beginning of the scale, is of a magnitude equal to almost 414 degrees of the scale. If the height of both the manometer and thermometer be given, the height of the barometer may be determined also.

**MANOR**, was a district of ground held by lords, or great personages, who kept in their own hand so much land as was necessary for the use of their families. The other lands they distributed among their tenants. The residue of the manor, being uncultivated, was termed the lord's waste, and served for common of pasture to the lord and his tenants. All manors existing at this day must have existed as early as King Edward I., and must have a court baron.

**MANSE**, MANSUS, MANSA, or MANSUM, in ancient law-books, denotes a house, or habitation, either with or without land. *See* HOUSE and MANSION. The word is formed from *à manendo*, "abiding;" as being the place of dwelling or residence.

**MANSLAUGHTER.** *See* HOMICIDE.

**MANTLE**, or MANTLE-TREE, in Architecture, the lower part of the chimney, or that piece of timber which is laid across the jambs, and sustains the compartments of the chimney-piece.

MANTLE, or *Mantling*, in Heraldry, that appearance of folding of cloth, flourishing, or drapery, which in any achievement is drawn about a coat of arms. *See* HERALDRY.

**MANTELETS**, in the art of war, a kind of moveable parapets, made of planks about three inches thick, nailed one over another, to the height of almost six feet, generally cased with tin, and set upon small wheels, so that in a siege they may be driven before the pioneers to shelter them from the enemy's small shot.

**MANTIS**, a genus of insects, of the order hemiptera. There are upwards of 60 species; the chief is the M. oratorea, or camel cricket, found in the southern parts of Europe, of a beautiful green colour, nearly three inches in length, of a slender shape, and in its general sitting posture, is observed to hold up the two fore legs as if in the act of devotion. The insect is of a predacious disposition, living on smaller insects, which it watches for with great anxiety: it is also very pugnatious, and when kept with others of its own species in a state of captivity, they will attack each other with the utmost violence till one is destroyed. The conqueror devours his antagonist.

**MANUFACTURES** may be defined, the arts by which natural productions are brought into the state or form in which they are consumed or used. The principal manufactures are those of which the various articles of clothing are fabricated; as the woollen manufacture, the leather manufacture in part, the cotton manufacture, the linen manufacture, and the silk manufacture; others supply articles of household furniture, as the manufactures of glass, porcelain, earthenware, and of most of the metals in part; the iron manufacture furnishes implements of agriculture, and weapons of war; and the paper manufacture supplies a material for communicating ideas and perpetuating knowledge.

**MANURE**, *See* HUSBANDRY.

**MAPLE.** *Acer Pseudo Platanus.* By tapping this tree it yields a liquor not unlike that of the birch tree, from which the Americans make a sugar, and the Highlanders sometimes an agreeable and wholesome wine.

**MAPS.** A map represents the earth, or only a portion of its surface, as Great Britain. The former are called universal: the latter, particular maps. The upper part of a map is the north, the lower the south, the east is on the right hand side and the west is towards the left hand, if the map be laid before you as it can be read. The latitudes are marked on the perpendicular margins of the east and west; the longitudes on the horizontal margins at top and bottom.

*The Construction of* MAPS.—*Prob.* I. *To construct a Map of the World, on the plane of a meridian* 41° *by the globular projection of the sphere.* (See the Plate, fig. 1.)—The globular projection of the sphere, represents spaces on the surface of the globe by equal spaces of the projected map, as nearly as a spherical surface can be represented on a plane. The plane of a meridian is the plane of one of the great circles of the sphere passing through both poles, and crossing the equator at right angles. A hemispherical map, is a representation of the entire surface of the Earth, projected on the plane of one of its great circles.

1. *To draw the meridians, or circles of longitude.*—Draw A B and N S at right angles to each other. A B represents the equator, and N S the *axis* meridian. From C as a centre, with any radius, C A or C B, according to the size of your paper, describe the circle A N B S. This circle is then the plane of your projection. Divide the four radii, C A, C N, C B, C S, each into nine equal parts.

Now, to draw the meridian 80° west of Greenwich, we have the two poles, and the point 80° in the equator, A B. From N as a centre, and with N C as radius, describe the arc Z C Z; also from S, with the same radius, describe the arc X C X. Remove the compasses to the point 80 on the equator, and describe the arcs 1, 1, and 2, 2. Through the intersections at 1 and 2, draw lines from 2, 2, through the points 1, 1, till they intersect the diameter B A produced in D. Then will D be the centre from which, with the radius D 80°, or D N, or D S, the meridian of 80° west longitude from Greenwich must be described. The same radius will draw the meridian expressing 140° W. L.; and, in the other hemisphere, the corresponding meridians of east longitude.

The meridian of 50° is drawn in the same manner as that of 80°, except that the point 50 on the equator (A B) is the centre from which, with the radius C B, the intersections are made at *a*, *a*, and *b*, *b*, on the arcs described from N and S. The point E, where the lines *b a*, *b a*, meet on the equator, is the centre for the meridian of 50° W. longitude. The same radius serves for the other three meridians 30° within the circle of projection. In this manner are all the other meridians for both hemispheres to be drawn; as may be seen in the Plate, fig. 7.

2. *To draw the parallels of latitude.* (Fig. 2.)—Latitude is the distance of any place from the equator, north or south. The same construction remaining, and the radii C N, C S, divided each into nine equal parts. Divide the circumference A N B S into thirty-six equal parts, each quadrant A N, B N; A S, B S, will be divided into nine equal parts, which, being again subdivided into ten equal parts each, will give us 360 equal parts or degrees.

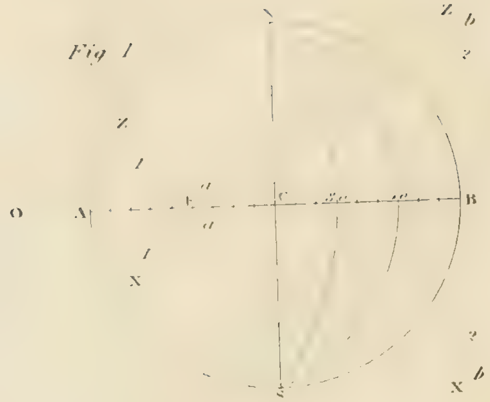
To draw, now, the parallel of 30° *north* latitude, set one foot of the compasses in the point 30 on the *axis* meridian N S, and with any radius describe the circle K T L. Set, again, one foot of the compasses in the points 30, 30, in the circumference, and intersect the circle K T L in the points *s*, *s*, *n*, *n*. Through *n n* and *s s* draw the straight lines *n n*, *s s*, meeting each other in the point R of the axis S N, produced to R; and with R as a centre, and R 30 as a radius, describe now the parallel of 30° north latitude. The same radius is used for 30° south latitude. After the same process the parallel of 60° north latitude is drawn, as may be easily conceived by inspecting the figure. And in this way proceed with all the other parallels in both hemispheres; as is evident from fig. 7.

This is the construction. The minutiæ of *filling up the map*, requires the attention of the delineator, in strictly observing the situations of objects or lines, as they respectively bear on the practice of map-making.

*Prob.* II. *To project a map of the world on the plane of a meridian, according and by the* stereographic projection *of the sphere.* Fig. 3. 1. *To draw the circles of latitude.*—Describe, from any centre C, the circle E N Q S, which will represent one-half of the earth's surface. Draw the diameters E Q and N S, intersecting each other at right angles. E Q is the equator, and N S the axis meridian. Divide the circumference into 360

# Construction of Maps

Fig. 1



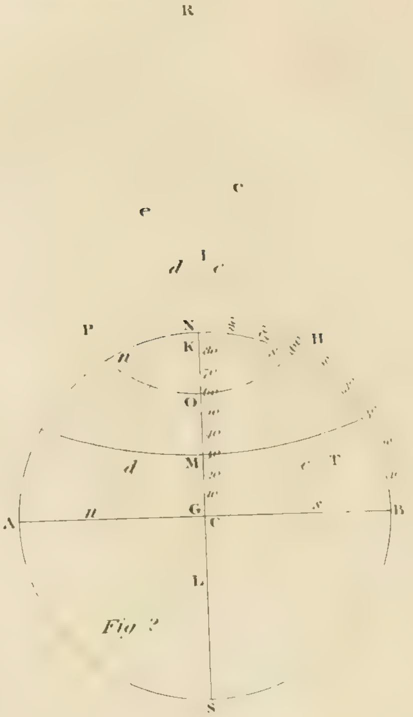


Fig. 2

Fig. 3

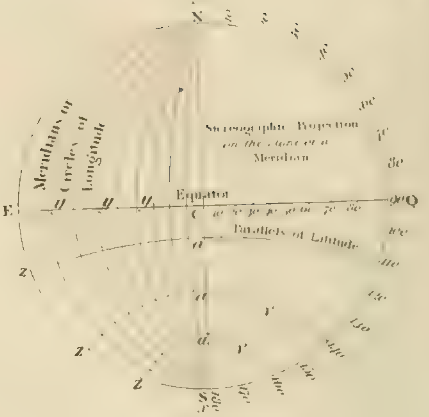
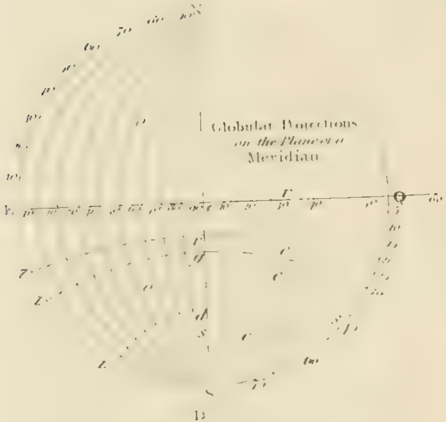

N
Meridians or Circles of Longitude
Stereographic Projection on the Plane of a Meridian
Equator
E
C
90 Q
Parallels of Latitude
Z
d
S

Fig. 4



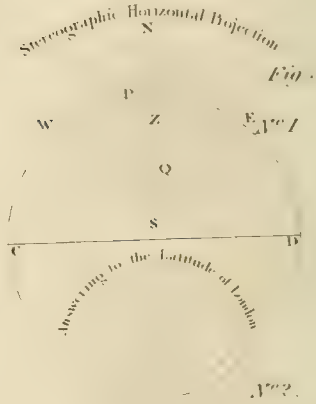
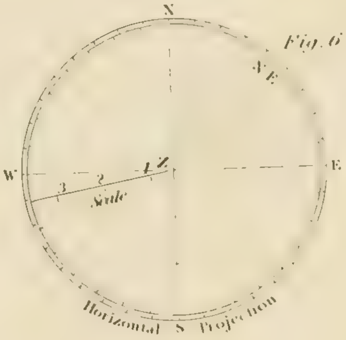

Stereographic Horizontal Projection
N
P
W
Z
E
Q
S
C
D
Answering to the Latitude of London

Fig. 5

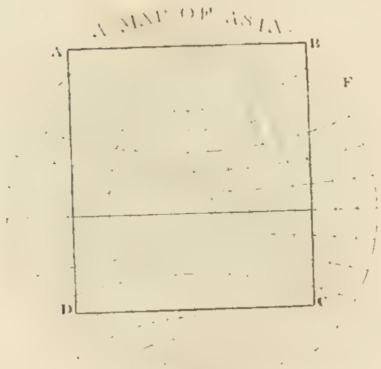
No. 1

No. 2

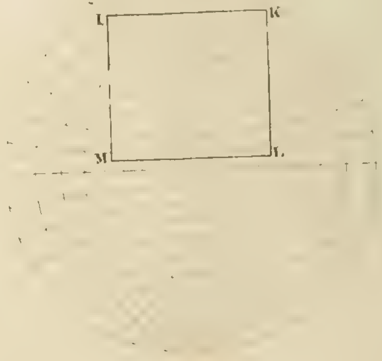
Fig. 6



A MAP OF ASIA.

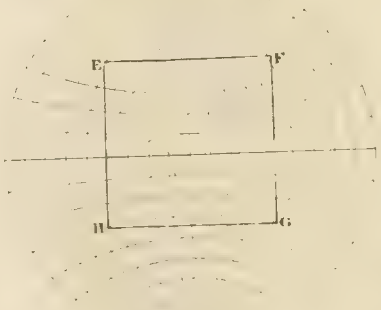


NORTH AMERICA



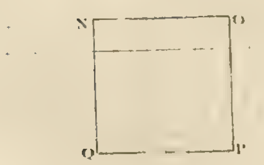
AFRICA

Fig. 7.



SOUTH AMERICA.

Fig. 8.



Orthographic Projection on the Plane of a Meridian

Fig. 9

equal parts; numbered 10, 20, 30, &c. as on the figure. From E to 140 draw the line E 140; bisect the portion *a* 140 in *v*, and from *v* draw the perpendicular *v x*, which produce till it meet N S produced in *x*. The point *x* is the centre from which to describe the parallel *z a* 140; or, the 50th degree of *south* latitude. The same radius will serve for the 50th parallel of *north* latitude; and after the same manner all the other parallels in both hemispheres are drawn, as they are fully shewn in fig. 8.

2. *To draw the circles of longitude.*—The unequal divisions of the equator, as indicated by the numbers 10, 20, 30, &c. on the radius C Q, and which are obvious from No. 1, fig. 11. The points 20, 40, 60, 80, are centres on which the circles of longitude S *y* N are to be drawn; for the remaining circles, produce the diameter E Q, and from N, through every tenth degree in the quadrant N Q, draw lines cutting that diameter produced, and the points of intersection will give the centres for the remaining circles of longitude: observe, however, that each centre is twenty degrees distant from the preceding one. For the circles of longitude in the other semi-hemisphere, the centres may be formed by setting off the proper distances on the diameter E Q, produced the contrary way.

*Prob.* III. *To draw a map of the earth on the plane of a meridian, according to Dr. Jamieson's* globular projection *of the sphere.* Fig. 4.—1. *To draw the circles of latitude.*—Describe the circles E N Q S; draw the diameters E Q and N S at right angles; the former represents the equator, and the latter the axis meridian. Divide the quadrant Q S into nine equal parts, 10, 20, 30. &c. From each of these divisions draw lines, as E *f* 20, E *g* 30, E *d* 60, &c. Divide into two equal parts the portions *f* 20, *g* 30, *d* 60, &c. and from *c*, the point of division, let fall the perpendiculars *c* F, *c* G, and *c* D, produced till they cut the polar diameter extended indefinitely. The points F, D, G, are centres, from which the circles of latitude *z f* 20, *z* G 30, *z d* 60, are to be described, and which will be the true representation of the parallels 20, 30, and 60 degrees of *south* latitude. In the same manner, draw the parallels for every tenth or fifth degree in that semi-hemisphere. To obtain those in the northern hemisphere, set off on the line S N produced, in the opposite direction, the distances which served as centres of the southern parallels: and the northern ones may be described for every tenth degree of latitude.

2. *To draw the circles of longitude.* Fig. 4.—Divide the quadrant E N into equal parts, 10, 20, 30, &c. Divide also the quadrant SQ into two equal parts at *s*, of 45° each, and let fall the perpendicular *s s* from the point *s*. Set off, on the line N S produced, S R equal to *s s* (see fig. 10), then, lines drawn from R to 10, 20, 30, &c. in the quadrant W S, will divide the radius in the points 10, 20, 30, &c. through which the circles of longitude are drawn (in fig. 4,) in the following manner:—

To find the centre of the circle S 30 N, join the points S 30, and N 30; divide the two lines into two equal parts in *o*, and let fall the perpendiculars *o* 30; and the point *r*, where they meet, is the centre of a circle of 30 degrees of longitude. The other centres may be found exactly in the same manner. Or the centres may be found, mechanically, from the following TRIGONOMETRICAL TABLE of RADII:—

Let the radius of the circle be divided into 100 equal parts by a scale; then the meridian or circle of

| | will be equal to | |
|---|---|---|
| 10° | | 12 |
| 20° | | 25 |
| 30° | | 42 |
| 40° | | 61.5 |
| 50° | | 88 |
| 60° | | 133 |
| 70° | | 208 |
| 80° | | 464 |

of those parts set off from C towards Q, added to the distance between C and the several points 10, 20, 30, &c. in the radius E C.

Thus the radius of the circle of 10° of longitude is equal to the distance between 10 in the line E C, and 10 in the line Q C; the radius of that of 50° = the distance between 50 and 50; that of 80° between 80 in the line E C and a given point in E Q, produced; which, taken from C, will be = 342 parts, of which radius is = 100.

*Prob.* IV. *To project a map of the earth stereographically, according to the* horizontal *projection of the sphere, and answering to the latitude of London,* (see *Dr. Mead's treatise on Maps.*) See fig. 5. *To draw the meridians.*—With any radius, S C or S D, describe the circle C P D, which divide as usual into 360°, and draw C D, P S, at right angles to each other; then will P S be the first meridian, or the north and south *azimuth. Azimuth*, or *vertical circles*, are great circles of the sphere, intersecting each other in the zenith and nadir, and cutting the horizon at right angles. On the quadrant D P set off D E = 51½° = the latitude of London, and draw parallel to C D, W E, the east and west *azimuth* of the place. Bisect W E in the point Z, which will be *London*, or *the place of projection.* The letters E, S, W, N, represent the four cardinal points, bearing due east and west, north and south, from London (Z), as the centre of the projection. And P, the pole of the meridional projection, is also the pole of the horizontal projection. Describe now the meridians of the meridional projection C P D, observing to allow them to pass through the pole P, beyond the primitive circle, and to touch the horizontal projection in the segment W N E.

*To describe the parallels of latitude.*—Lay a ruler upon W, and move it to every degree, or every tenth degree of the meridian P D continued, marking where it cuts the meridian N S, for through these points the parallels on this side of the pole must all pass. But, as they have not a common centre, the points through which they pass on the other side of the pole are found by moving the ruler along every tenth degree of the meridian P C continued; for wherever the ruler intersects the meridian, N S will be the opposite points through which the parallels are to pass. Having now obtained the diameters of the parallels, we have only to bisect each of them, and with one half, as a radius, describe the correspondent parallel. In fine, the projection may now be completed, as shewn in fig. No. 2.

*Prob.* V. *By the globular projection of the sphere, to construct a map with* azimuth *lines, to shew the* bearing *and* distance *of all places within the map, from London, or any other given place in the centre.* (See fig. 6.)—It will be perceived that, in this projection, the longitude and latitude of places are neglected, because the map is restricted to the bearing and distance only of places from a station in the centre. Describe a circle of any radius, cross it with two diameters; N S represents the meridian of the place assumed as the centre, or the north and south line; and W E, the east and west line, may be considered the parallel of latitude passing over the place. The intersection of the diameters, as at Z, indicates the place in the centre. Divide each quadrant into 90°, of the exterior circle; and the inner circle into 32 equal parts, to indicate the points of the mariner's compass.

The lines radiating from Z are the bearing lines. The three concentric circles, described from the common centre Z, may be assumed as one degree each; and the scale will then contain 180 geographical, or 208½ English, miles. Suppose we place *London* in the centre; then, by the help of the Table of Latitude and Longitude, page 593, we may transfer, into this projection, all places within 180 miles of London.

The numbers 1, 2, 3 degrees, on the scale from the centre, are arbitrary, and may be reckoned 10, 20, 30 degrees; in which case our projection will embrace 1800 geographical, or 2085 English, miles. Or, if the radius, or scale, be divided into 4, 5, 6, or any given number of equal parts, each of those parts may represent 4, 5, 6, or 40, 50, 60, degrees. The scale in this projection must be considered a moveable slip of Bristol board, graduated according to the radius of the projection, and riveted on the map by means of a neat button. Its use is obvious; for, by moving it round, we determine the bearing and distance, at once, of all places from London, or any other place (Z), in the centre.

Fig. 7, represents the globular projection of the sphere; in which the rectangular figure A B C D represents the skeleton of the map of Asia. The parallelogram E F G H, the skeleton of the map of Africa. The rectangular figure I K L M, the skeleton of the map of North America. The parallelogram N O P Q, the skeleton of the map of South America. Projected on a large scale, these skeletons afford ample exercises for the display of genius and taste in the subsequent *filling up*, shading, lettering, and colouring.

*Prob.* VI. *To construct a map of the world, on the plane of a meridian, according to the* orthographic *projection of the sphere.* (Fig. 10.) *To describe the meridians, which are ellipses.*—If they be described through every tenth degree on the equator, the distance of each successive meridian, from the centre of the map, is found by means of the parallels drawn through the corresponding divisions of the circumference. If these elliptical meridians are drawn with a pair of elliptical compasses, through every fifteenth degree of the equator from the centre of the map, they will appear as in fig. 9.

*To draw the parallels of latitude, which are straight lines.*—If at 10° from each other, lines be drawn parallel to the equator, they will indicate the parallels of latitude. But, if they be drawn through every fifteenth degree of latitude, they will appear as in fig. 9.

*Note.*—This projection is chiefly useful for astronomical purposes, to represent a sign of the Zodiac. It is obvious, that twelve such projections would furnish the means of depicting the twelve signs.

*Prob.* VII. *To project, on the plane of the equator, a map of the world, according to the globular projection of the sphere.* (Fig. 10.)—In fig. 10, the point R is distant from N equal to the line *s s*, or the sine of 45° in fig. 4. This point R is the place of the eye whence the spectator, supposing the sphere pellucid, views the entire hemisphere W S E. The lines which pass from 10, 20, 30, &c. in W S to the eye at R, cross the line W P obliquely in the points 10, 20, 30, &c. Thus, the equal division, or nearly so, of the radius is obtained; and this is the principle of the globular projection of the sphere.

1. *To draw the meridians; which, in this map, are straight lines, radiating from* P, *the pole.*—Divide the circumference into 36 or 360 equal parts, and to each of these equal divisions draw straight lines, as seen in No. 2; and the meridians for one hemisphere, projected on the plane of the equator, are now laid down.

2. *To draw the parallels of latitude; which, in this map, are concentric circles, described, with their respective radii, from* P *the common centre.*—From the observation with which we have prefaced this construction, we know that W P, the radius (No. 1), is divided into nine equal parts. Then, with the respective radii, P 10, P 20, P 30, &c. of No. 1, describe the concentric circles, as shewn in No. 2, and one hemisphere is completed, so far as respects the projection of the meridians and parallels.

Countries, sea-coasts, towns or places, mountains, rivers, &c. are now to be laid down from tables of Latitude and Longitude.

*Prob.* VIII. *To construct a map of the world, on the plane of the equator, according to the stereographic projection of the sphere.* (See fig. 11.)—As, in this projection, the eye of the observer is placed on the surface of the sphere, and in either pole, as at N (No. 1), the straight lines drawn from the equal divisions of the quadrant W S to the point N, cut the radius W P into unequal divisions, we derive, at once, the principle of the stereographic projection of the sphere, in which equal spaces on the surface of the earth are represented by unequal spaces on the projection; the space W 10 being double of P 80; and, consequently, if P 80 be 1, W 10 will be 2; and any quadrilateral continued between W 10 and 10° of latitude, on a projection on the plane of the meridian, will be four times the size of a quadrilateral comprehended by P 80 and 10° of latitude, because the square of 2 is 4, and the square of 1 is 1.

I. *To project the meridians; which, in this, as in the last Problem, are straight lines.*—The directions given in that Problem apply perfectly to this; and the process is the same in both.

II. *To draw the parallels of latitude, which, as in the former projection, are concentric circles.*—Take P as the common centre, and with the radii P 10, P 20, P 30, &c. of No. 1, respectively, describe the concentric circles, which shall represent the parallels, as shewn in No. 2.

The note subjoined to the last Problem, is to be observed in the execution of this projection.

*Prob.* IX. *To project a map, on the plane of the equator, according to the* orthographic *projection of the sphere.* (See fig. 12.)—As the eye of the observer is supposed, in this projection, to be situated at an *infinite* distance from the surface of the sphere, all the lines which are drawn on it are straight lines. On this principle, the *meridians* would appear, to an eye so situated, as in No. 1, fig. 12; and the *parallels* would also be straight lines, as represented in fig. 9. But, on the plane of a meridian, a map constructed according to this projection has its meridians drawn elliptical, while its parallels are straight lines. (See fig. 9.) Whereas, on the plane of the equator, the same laws are observed as in the two last projections, and the meridians are radiating straight lines; while the parallels are concentric circles, described from the common pole.

1. *To draw the meridians.*—Proceed as in the two last problems for their meridians.

2. *To draw the parallels of latitude.*—Through the points 80, 70, 60, 50, 40, 30, 20, and 10, of the semicircle N W S, (fig. 12, No. 1,) draw straight lines parallel to N P S; and the divisions 80, 70, &c. on P W, are the divisions which indicate the law of the projection, and the radii for the concentric parallels, which are respectively drawn on No. 2.

*Scholium.* On reviewing these projections, the globular (fig. 10) has decidedly the advantage of presenting equal spaces of latitude throughout its successive geographic quadrilaterals; the stereographic (fig. 11,) presents unequal spaces, diminishing towards the pole, but allowing us more space than the globular for those countries situated near the equator; and, in this respect, answering better than the other the conditions of the projection. The orthographic is the reverse of this last, as it allows to the polar regions more space than either of the other two; but then the countries contiguous to the equator are abandoned to a greater error in respect of latitude than even the polar regions in the stereographic projection. For geographical purposes, the globular is preferable; for astronomical uses, the stereographic merits attention, when the signs of the Zodiac, or stars within the tropics, are to be laid down, as seen from either pole; and the orthographic suits best the delineation of the arctic or antarctic constellations.

*Prob.* X. *To project a map of Asia, according to the globular projection.* (See fig. 13.)—Having drawn any indefinite line A X, and assumed a distance A *k* for 10° of latitude, set off this distance nine times from A toward X. The point 9, or 90, will be the pole. With the distance A *k* set off A B = A D, because the degrees of longitude on the equator correspond with those of latitude on a meridian of the sphere. At the point *a*, or 70° of latitude, set off *a b*, and *a d*, each equal to 20·52; the number of geographical miles corresponding to 70°. Through the points B *b*, D *d*, draw the oblique lines B *b*, D *d*, which, constructed by the laws of decreasing longitude, terminate in the point X. This point (X) is, therefore, the common centre for all the parallels of latitude; and it is 30 degrees beyond the pole P, or at the same distance north of the parallel of 60 degrees, that the equator is south of it. On the equator, E A Q, set off the portion A B, or A D, as often as may be necessary to answer the conditions of the projection; and from each of these points, 50, 60, 70, &c. draw lines to the point X, and they will indicate the meridians, which are all straight lines. Set, now, one foot of the compasses in the point X, and with the other describe the successive concentrics, 10, 20, 30, &c. for the parallels of latitude. Through the point A draw M L, at right angles to A X; raise the two perpendiculars M O, L W, and draw O W, completing the parallelogram O M L W. The degrees of longitude, as on the equator E A Q, or of latitude, as on the meridian 140°, may now be inserted; or upon the parallel lines O M, W L, and O W, M L.

The outline of the Asiatic continent, as in the figure on the Plate, will materially assist the student; but his great reliance must be in a Table of Latitude and Longitude. The eye is never to be depended on where the process of operation proceeds on such data as an accurate Table affords.

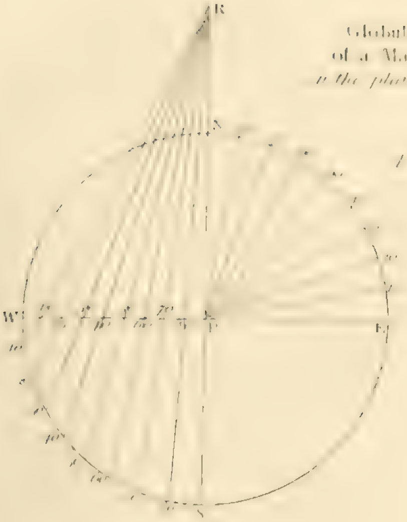
*Prob.* XI. *To project a map of a particular portion of the earth's surface, as of Italy, containing* 6° *of latitude,* (viz. *from the* 39*th to the* 45*th degree,*) *and* 9° *of longitude,* (viz. *from the* 7*th to the* 16*th of east longitude.*)—(Fig. 14.)—Draw the line E F, and in the middle of this line raise the perpendicular D C, which divide into six equal parts, or degrees of latitude, and through C draw the line I K parallel to E F. The projection is to be regulated, as to size, by the size of the paper. Divide a degree into 10 equal parts, or, if large enough, into 60; and find the number of miles which a degree of longitude contains in the latitude of 39°, *viz.*—46·62, and, from any scale of equal parts, set off one half of the same, *viz.*—23·31, on each side of D. Find the number of miles contained in a degree of longitude, in the latitude of 45°, *viz.*—42·43; and from the same scale of equal parts, from which the former measure was taken,

# *Construction of Maps*

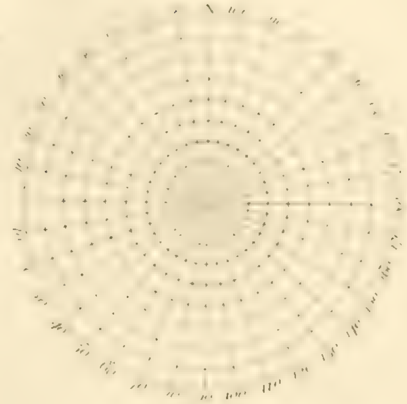
PL. 2.

Globular Projection
of a Map of the World
*on the plane of the Equator*

Fig 10



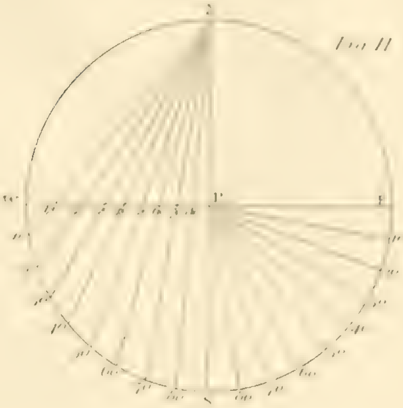
No 1



No 2

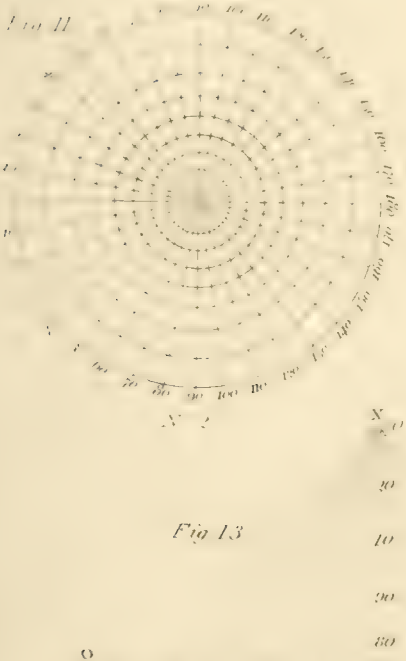
Stereographic Projection of a Map of the World
*on the plane of the Equator*

Fig 11



No 1

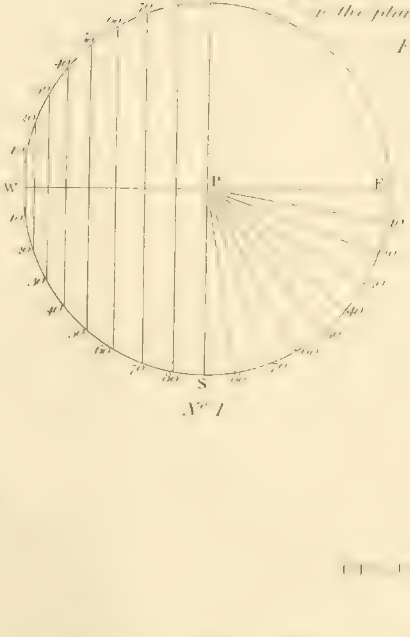
Fig 11



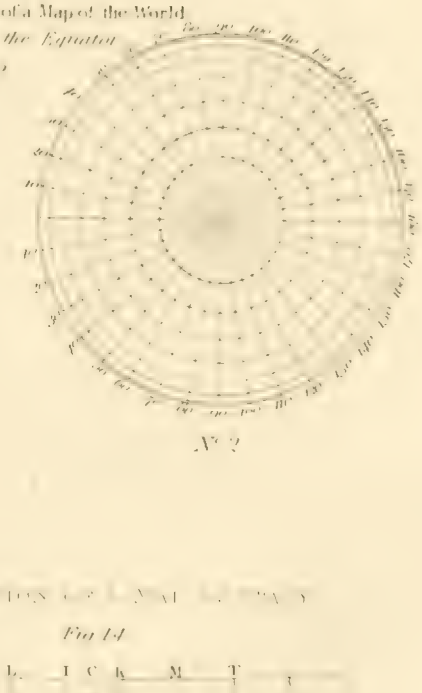
No 2

Orthographic Projection of a Map of the World
*on the plane of the Equator*

Fig 12

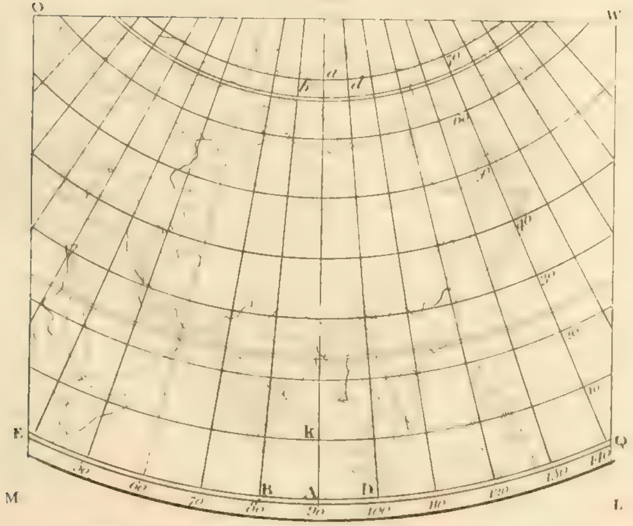


No 1



No 2

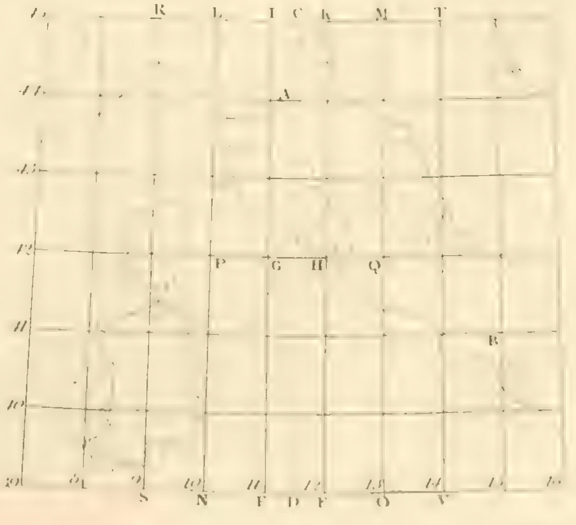
Fig 13



CONICAL PROJECTION OF A MAP OF ASIA

PROJECTION OF A MAP OF ITALY

Fig 14



set off 21·215 on each side of C. Draw straight lines from I to E, and from R to F; divide them into the same number of parts as the line C D contains, and through the points draw parallel lines. Thus, I K F E is a projection for one degree of longitude, including six degrees of latitude.

Since the degrees must be so drawn, that the two diagonal lines in each must be equal to each other, they are to be projected in the following manner:—1. Take the distance from E to K, or from F to I, and, setting one foot of the compasses first in E, and then in F, describe the arcs L and M. Then set one foot, first in I, and afterwards in K; and, with the same extent, draw the arcs N and O. 2. Take the distance between E and F, and set it off on the arcs described from E to N, and from F to O; then take the distance between I and K, and set it off from I to L, and from K to M. 3. Draw the lines between L and N, and M and O; divide them into degrees, and draw parallels from those points to the corresponding ones in the meridians I E and K F. The same method must be pursued in drawing all the other meridians and parallels which the conditions of the map require.

Should the map be very large, so much so that the compasses will not extend to the furthest degree, or from F to I, then draw one or more diagonals at once, and afterwards proceed with the rest. Thus, when the parallelogram P G E N and and H Q O F are described, L I G P and K M Q H may be done. Number the degrees of latitude up both sides of the map, and the degrees of longitude on the top and bottom. Then make the proper divisions and subdivisions of the country; and, from a Table of Latitudes and Longitudes, it will be easy to set down in the map the principal places which should be found in it; for any town must be placed in the intersection of the lines which would indicate its latitude and longitude.

Thus *Florence* must be placed at A, where the circles of 43° 46′ 30″ N. lat. and of 11° 3′ 30″ E. long. cut each other. And *Naples* must be placed at B, on the sea-shore, at 40° 45′ 15″ N. lat. and 14° 17′ 30″ E. long. In like manner, the mouth of a river, as the Tiber, for instance, must be set down; but, to describe its whole course, every turning must be laid down according to its latitude and longitude, and the towns and bridges also by which it passes.

*Obs.* In the projection we have now described, the diagonals being all equal, the number of meridians creates no defect in the representation, because equal spaces on the globe are represented by equal spaces on the map; consequently, places lying in the most remote degrees of longitude are as truly represented as those towards the middle of projection, and their distances will agree with a common measure; so that a pair of compasses, extended between any two places, and applied to the scale, will give the distance without further trouble. When the extent of country is not great, of which a map is to be made, as of a province or country, for example, the meridians, as to *senes*, are parallel to each other, and may be represented by straight lines. The whole, indeed, will differ so very little from a plane, that it will be sufficient to measure the distances of places in miles, and to lay them down in a plane right-lined map, of which the successive spaces, formed by the meridians and parallels, would be right-angled parallelograms, or, more properly, squares.

*Prob.* XII. *To project a map of Europe.*—Having drawn a line for the central meridian of the map, numbered in the Plate 20, 20, assume any convenient distance for 5°, and set it off on this meridian seven times from 35° to 70°; or, to obtain at once the common centre for all the parallels of latitude, set it off 11 times from 35, because 90 — 35 = 55, and 55 ÷ 5 = 11 equal the number of spaces of 5° between 35 and 90. The eleventh, or extreme division, is the pole; and 6½ degrees more, beyond it, will be the common centre from which the successive and concentric parallels of latitude are to be drawn.

To draw the meridians, take from a Table of decreasing Latitude, the number of miles in 35° latitude, and set this off as often as is necessary on each side of the central meridian (20°), on the parallel, or circle, of latitude 35°. From these points of division draw right lines to the common centre, and they will represent the meridians. But, because the meridians in this map are portions of circles, they are curved after the following manner:—Take the number of miles in 40°, and set this off on the parallel of 40°; take from the Table the number of miles in 45°, and set this off on the parallel of 45°; take for 50°, 60°, 65°, 70°, in like manner; and, having set off these measures on the concentric parallels as often as necessary, the points, when joined to indicate the meridians, will form as many segments of circles as there are meridians: and hence the construction is obvious.

For the purpose of drawing maps geometrically correct, it is necessary that schools, or preceptors, or students for themselves, provide a *bow-rule* and also *beam-compasses.* The former is purchased at any mathematical instrument maker's for half-a-guinea; and the latter seldom exceeds twenty-five or thirty shillings. In drawing large maps, it will be found most convenient to fasten down the edges of the paper on an even board, which is covered with a smooth oil-cloth.

*Prob.* XIII. *To construct a map, which shall contain the degrees of longitude and latitude of Great Britain.*—This island lies between 50° and 60° N. latitude, and between 2° E. and 6° W. longitude. Having, therefore, chosen any unit of measure for a degree of latitude, the degrees of longitude must be proportioned to it. The length of a degree of longitude in latitude 5° is to one of latitude as 38·57 is to 60; that is to say, a degree of longitude is something more than half the length of a degree of latitude. The exact proportion may, however, be had by a diagonal line, which is divided thus:—Draw an indefinite line, of perhaps three inches; at each extremity raise two perpendiculars, which make equal to the assumed degree of latitude; complete the parallelogram by drawing its fourth side parallel to the first or base line; reduce the figure to two right-angled triangles by a diagonal. Divide this diagonal into 60 equal parts, and through the points of division draw lines parallel to the sides of the parallelogram, which are of equal length with the degree of latitude. The length of a degree of longitude in latitude 60°, is 30·00. Of course, on the diagonal scale, we take off this quantity where the number 30 is found. Then, on each side of the perpendicular, on which we set off the degrees of latitude, this measure 30 is set off three times to the east, and seven times to the west, to answer the conditions of the map. For the corresponding measures at 50° of latitude, take off at 38·57 on the diagonal scale, the proper quantity, and set it off thrice to the east, and seven times to the west, of the perpendicular, or first meridian. Through the corresponding points, at 50° and 60° of latitude, draw now the meridians; and, through the equal divisions on the first meridian, draw the parallels of latitude. Then, from 3° east and from 7° west longitude, raise perpendiculars, which will complete the parallelogram that must contain the map. Having next divided into *minutes* and *seconds* the degrees of longitude and latitude, towns, cities, or rivers, or mountains, may be accurately laid down; since, by intersectional lines through the correspondent points of latitude and longitude, whatever is to be represented on the map may be readily depicted. A mariner's compass, on any such map, will shew the bearing of one place from another.

*Prob.* XIV. *To construct Mercator's Chart of the World.*—Draw any indefinite line for an equator, marked *o* EQUATOR *o* in the Plate. Assume any point on this line for the position of the *first* meridian; that is to say, the Meridian of Greenwich. Take any assumed distance in the compasses for 10° of longitude, or the unit of measure; set this off on the equator from *zero* (0), or the meridian of Greenwich, eighteen times on both sides of *zero.* Then will 360° of longitude be set off; because 18 + 18 = 36, which, multiplied by 10°, gives 360°. Through those 36 equal divisions on the equator draw straight and parallel lines at right angles to the equator: these straight and parallel lines will be the meridians 0, 10, 20, 30, &c. and which, on the projection, are continued across the chart at every 20th degree of longitude, east and west of *zero,* or Greenwich.

**MARANTA,** *Indian Arrow Root,* a genus of the monandria monogynia class and order. Natural order scitamineæ. There are five species, of which the Indian arrow root has a thick, fleshy, creeping root, full of knots, from which arise many smooth leaves, six or seven inches long, and three broad towards their base; the stalks about two feet high, the ends of which are terminated by a loose bunch of small white flowers, standing upon peduncles two inches long: the flowers are cut into six narrow segments, indented on their edges; these sit upon the embryo, which afterwards turns to a roundish three-cornered capsule, enclosing one hard rough seed. It is called Indian arrow-root, because it was thought to extract the poison from wounds inflicted by the poisoned arrows of the Indians. The root washed, pounded fine, and bleached, makes a powder and starch; it is recommended as a proper food for infants, and is gelatinous like salep. It is a native of South America, and is cultivated in the West Indies.

MARBLE, is a kind of stone, found in great masses, and dug out of pits or quarries. It is of so hard, compact, and fine a texture, as readily to take a beautiful polish. There are infinite numbers of different kinds of marble. Some are of one simple colour, as white or black; others variegated with stains, clouds, waves, and veins; but all opaque, excepting the white, which, cut into thin pieces, becomes transparent. Marble is found in considerable quantities in most of the mountainous parts of Europe. Derbyshire is that county of England most abounding in this article. Italy is that part of Europe which produces the most valuable marble. The black and the milk-white marble, coming from Carara, a town in the duchy of Massa, are particularly esteemed.

MARBLE, *Polishing of*, is performed by first rubbing it well with a freestone, or sand, till the strokes of the axe are worn off, then with pumice stone, and afterwards with emery.

*Florence* MARBLE, a kind of hardened marl, is cut into mosaic work, and framed like pictures, which sometimes fetch a high price. If held at a distance from the eye, an inexperienced observer might mistake a slab of Florence marble for a drawing in bistre; for ruins of Gothic buildings, mouldering fragments of cathedrals, and ruinous walls, shattered bastions, and decayed towns, appear in the picture, which on a closer examination offers nothing but irregular spots, lines, and shades.

*Imitation of* MARBLE, is made from plaster of Paris, quick lime, salt, ox-blood, stones of different colours, and pieces of glass. These are all beaten to an impalpable powder, and mixed up to the consistency of a paste by the agency of beer, or some milk. When thoroughly dried in the form which is intended to be given to it, the mass or surface is rubbed with very fine sand-paper, and polished with leather and oil.

MARBLING, the method of preparing and colouring the marbled paper. There are several kinds of marbled paper, but the principal difference of them lies in the forms in which the colours are laid on the ground; some being disposed in whirls or circumvolutions, some in jagged lengths, and others only in spots of a roundish or oval figure. The general manner of managing each kind is, nevertheless, the same, being the dipping the paper in a solution of gum tragacanth, or, as it is commonly called, gum dragon; over which the colours, previously prepared with ox-gall and spirit of wine, are first spread. The peculiar apparatus necessary for this purpose, is a trough for containing the gum tragacanth and the colours, a comb for disposing them in the figure usually chosen; and a burnishing stone for polishing the paper. The trough may be of any kind of wood, and must be somewhat larger than the sheets of paper for marbling which it is to be employed; but the sides of it need only rise about two inches above the bottom, for by making it thus shallow, the less quantity of the solution of the gum will serve to fill it. The comb may be also of wood, and five inches in length, but should have brass teeth, which may be about two inches long, and placed at about a quarter of an inch distance from each other. The burnishing stone may be of jasper or agate; but as those stones are very dear when of sufficient largeness, marble or glass may be used, provided their surface be polished to a greater degree of smoothness. These implements being prepared, the solution of gum tragacanth must be made, by putting a sufficient proportion of the gum, which should be white, and clear from all foulness, into clean water, and letting it remain there a day or two, frequently breaking the lumps, and stirring it till the whole shall appear dissolved, and equally mixed with the water. The consistence of the solution should be nearly that of strong gum water used in miniature painting; and if it appear thicker, water must be added; or if thinner, more of the gum. When the solution is thus brought to a due state, it must be passed through a linen cloth, and being then put into the trough, it will be ready to receive the colours. The colours employed for red are carmine, lake, rose-pink, and vermilion; but the two last are too hard and glaring, unless they be mixed with carmine or lake, to bring them to a softer cast; and with respect to the carmine and lake, they are too dear for common purposes. For yellow, Dutch pink and yellow ochre may be employed: for blue, Prussian blue and verditer may be used.: for green, verdigris, a mixture of Dutch pink and Prussian blue or verditer, in different proportions: for orange, the orange lake, or a mixture of vermilion or red lead with Dutch pink: for purple, rose-pink and Prussian blue. These several colours should be ground with spirit of wine, till they be of a proper fineness; and then at the time of using them, a little fish-gall, or, in default of it, the gall of a beast, should be added, by grinding them over again with it. The proper proportion of the gall must be found by trying them; for there must be just so much as will suffer the spots of colour, when sprinkled on the solution of the gum tragacanth, to join together, without intermixing or running into each other. When every thing is thus prepared, the solution of the gum tragacanth must be poured into the trough, and the colours being in a separate pot, with a pencil appropriated to each, must be sprinkled on the surface of the solution, by shaking the pencil, charged with its proper colour, over it, and this must be done with the several kinds of colour desired, till the surface be wholly covered. When the marbling is proposed to be in spots of a simple form, nothing more is necessary; but where the whirls or snail-shell figures are wanted, they must be made by means of a quill, which must be put among the spots to turn them about, till the effect is produced. The jagged lengths must be made by means of the comb above described, which must be passed through the colours from one end of the trough to the other, and will give them that appearance; but if they be desired to be pointed both ways, the comb must be again passed through the trough in a contrary direction; or if some of the whirls or snail-shell figures be required to be added, they may be yet made by the means before directed. The paper should be previously prepared for receiving the colours, by dipping it over-night in water, and laying the sheets on each other with a weight over them. The whole being thus ready, the paper must be held by two corners, and laid in the most gentle and even manner on the solution covered with the colours, and there softly pressed with the hand, that it may bear every where on the solution. After which, it must be raised and taken off with the same care, and then hung to dry across a proper cord, subtended near at hand for that purpose; and in that state it must continue till it be perfectly dry. It then remains only to give the paper a proper polish; in order to which, it is first rubbed with a little soap, and then must be thoroughly smoothed by the glass polishers, such as are used for linen, and called the calendar glasses. After which it should be again rubbed by a burnisher of jasper or agate; or in default of them, of glass ground to the highest polish; for on the perfect polish of the paper depends in a great measure its beauty and value. Gold or silver powders may be used where desired, along with the colour, and require only the same treatment as them, except that they must be first tempered with gum water.

Marbling of books or paper is performed thus:—Dissolve four ounces of gum arabic in two quarts of fair water; then provide several colours mixed with water in pots and shells, and with pencils peculiar to each colour, sprinkle them by way of intermixture upon the gum water, which must be put into a trough or some broad vessel, then with a stick curl them, or draw them out in streaks, to as much variety as may be done. Having done this, hold your book or books close together, and only dip the edges in, on the top of the water and colours, very lightly; which done, take them off, and the plain impression of the colours in mixture will be upon the leaves, doing as well the ends as the front of the book in the like manner. Marbling a book on the covers is effected by forming clouds with aquafortis or spirit of vitriol mixed with ink, and afterwards glazing the covers. *See* BOOKBINDING.

MARCH. According to common computation, this is considered the third month in the year, but with the Romans it had the honour of being the first. When, however, chronology enumerates the years that have elapsed since the Saviour's incarnation, the calculation always begins with the twenty-fifth day of this month. In this country, prior to the alteration of the style, March stood foremost in the general order, but since that period the honour has been transferred to January. Before the year 1564 the French reckoned the beginning of the year from Easter, so that there were two months of March in one year, which they called *March before Easter*, and *March after Easter;* and whenever Easter happened in March, the beginning of the month was in one year, and the end in another. The first who is said to have divided the year into months was Romulus, who, from *Mars*, his supposed father, called this month March. Ovid, however, has observed, that the people of Italy used its present name long before the days of Romulus, but its situation was variously placed. It is, however, somewhat remarkable, that amidst all its chances March has uniformly consisted of thirty-one days. March among the ancients was invariably under the protection of Minerva, and, like May, was deemed unpropitious to marriage. The Romans in this month sacrificed to Anna Perenna, began their comitia, and adjusted their farms and leases. During this month the mistresses served their servants and slaves at their tables, as the masters did their slaves in the Saturnalia, and the vestals renewed their sacrifice.—For the flower garden, the shrubbery, the kitchen garden, the fruit garden, the greenhouse, the hothouse, and the nursery, this month furnish much employment, the particulars of which may be gathered from any gardener's calendar. It is the seed time of industry, for the toils of which the subsequent months will fully compensate.

MARIGOLD. *Calendula Officinalis.* An annual plant, usual in the spring. The petals of the flowers are eaten in broths, to which they impart a very pleasant flavour.

MARINE, a general name for the navy of a kingdom or state; as also the whole economy of naval affairs, or whatever respects the building, rigging, arming, equipping, navigating, and fighting ships. It comprehends also the government of naval armaments, and the state of all the persons employed therein, whether civil or military.

MARINE ACID. *See* MURIATIC ACID.

MARINE *Chair*, a machine invented for viewing the satellites of Jupiter at sea, and thereby determining the longitude by their eclipses.

MARINE *Remains*, a term used to express the shells of sea-fishes, and parts of crustaceous and other sea-animals, found in digging at great depths in the earth, or on the tops of high mountains.

MARINE *Surveyor*, the name of a machine contrived by Mr. H. de Saumerez, for measuring the way of a ship at sea. The machine is in the form of the letter Y, and is made of iron or other metal. At each end of the lines which constitute the angle or upper part of the letter, are two pallets, one of which falls in the same proportion as the other rises. The falling or pendent pallet, meeting a resistance from the water as the ship moves, has by that means a circular motion under water, faster or slower, according as the vessel moves. This motion is communicated to a dial within the ship, by means of a rope fastened to the tail of the Y, and carried to the dial.

MARINER, a person who gets his living on the sea.

MARINER'S *Compass*, an instrument used at sea by mariners to direct and ascertain the course of the ship. *See* COMPASS.

MARINES, a body of forces employed in the sea service, under the direction of the lords of the admiralty.

MARIOTTE, EDME, an eminent French mathematician and philosopher, was born at Dijon early in the seventeenth century, and died in 1684. He investigated a number of curious philosophical subjects, such as the collision of bodies; the pressure and motion of fluid; the nature of vision; the properties of atmospheric air, &c.; on which subject he had several ingenious papers in the Memoirs of the French Academy of Sciences, from vol. i. to vol. x.

MARITIME, something relating to, bounded by, or near the sea.—MARITIME *Powers*, those states which possess harbours, &c. on the sea coasts, and a powerful navy to defend them.

MARJORAM, WINTER. *Origanum Vulgare,*—This is used as a sweet herb, and is a good appendage to the usual ingredients in stuffing, &c. It is a perennial plant, and propagated by planting out its roots in the spring of the year.

MARJORAM, *Sweet. Origanum Marjorana.* This is also used for the same purpose as the last mentioned. It is an annual, and not of such easy culture as the last, requiring to be raised from seeds in an artificial heat. It is usually dried and kept for use.

MARK, in Commerce, a certain note which a merchant puts upon his goods, or upon the cask, hogshead, &c. that contains them, in order to distinguish them from others, such as a grape, a crow's foot, a diamond, a cross, an asterisk, &c.

MARK, or *Marc*, also denotes a weight used in several states of Europe, and for several commodities, especially gold and silver. In France, the mark is divided into 8 ounces, or 64 drachms, or 192 deniers or pennyweights, or 160 esterlins, or 300 mailles, or 640 felins, or 4608 grains. In Holland the mark weight is also called troy weight, and is equal to that of France. When gold and silver are sold by the mark, it is divided into 24 caracts.

MARK is also used among us for a money of account, and in some other countries for a coin. The English mark is two-thirds of a pound sterling, or thirteen shillings and four-pence, and the Scotch mark is of equal value in Scotch money of account. The mark-lubs, used at Hamburgh, is also a money of account, equal to one third of the rix-dollar, each mark is divided into 16 sols-lubs. Mark-lubs is also a Danish coin, equal to 16 sols-lubs. Mark is also a copper and silver coin in Sweden.

MARKET, the establishment of public marts or places of buying and selling, with the tolls belonging to it, is one of the king's prerogatives, and markets can only be set up by virtue of the king's grant, or by immemorial usage. All sales and contracts of any thing saleable in markets overt, will not only be good between the parties, but binding also upon all persons having any property therein. In London, every shop in which goods are exposed publicly to sale, is market overt for such things only as the owner professes to trade in. If a man buy his own goods in a market, the contract shall not bind him, unless the property had been previously altered by a former sale.

MARL, is a combination of alumine, silex, and alum, and is denominated calcareous, or argillaceous, or siliceous, as the lime, clay, or silex, is most abundant. The calcareous part of marl is frequently composed of shells, whence it frequently has the name of *shell marl;* and where these are predominant, it affords an excellent manure for sandy, dry, gravelly, or light lands of any kind. It likewise produces very beneficial effects on mossy and clayey soils; and these effects, if it have been properly applied, will frequently be observable for twelve or fourteen years. Some kinds of marl that contain but a small portion of lime have been successfully employed in the manufacture of earthenware. Marl is usually found at the depth of from five to nine feet beneath the surface of the ground, and deposited betwixt beds of clay and sand. It is dug out with spades; and in the digging of it in Ireland the workmen not unfrequently meet with the horns of deer and other curious fossils. The usual mode by which persons generally unacquainted with minerals distinguish this from other substances is, to break a small piece of dry marl into a glass of vinegar, where it will immediately dissolve with considerable effervescence; and the briskness of this effervescence will be in proportion to the quantity of lime which it contains.

MARLINE SPIKE, an iron, tapering to a point, used to separate the strands of a rope in order to introduce those of another, when they are to be spliced or joined evenly without knotting.

MARLING, the act of winding any small line, as mar-line, spun yarn, twine, &c. about a rope, so that every turn is secured by a kind of knot, and remains fixed in case the rest should be cut through by friction. It is commonly used to fasten slips of canvass on a rope, to prevent its being galled, or to fix the foot of a sail to its bolt rope.

MARQUE. *See* LETTERS OF MARQUE.

MARQUETRY, or INLAID WORK, is a curious work composed of several fine hard pieces of wood, of various colours, fastened in thin slices on a ground, and sometimes enriched with other matters, as silver, brass, tortoise-shell, and ivory. The ground on which the pieces are to be arranged and glued, is usually of well-dried oak, or deal, and is composed of several pieces, glued together to prevent its warping. The wood to be used in marquetry is reduced into leaves of the thickness of a line, or the twelfth part of an inch, and is either of its natural colour, or stained or made black to form the shades, by other methods: this some perform by putting it in sand, heated very hot over the fire; others by steeping it in lime water and sublimate; and others in oil of sulphur. The wood being of the proper colours, the contours of the pieces are formed according to the parts of the design they are to represent. The two chief instruments used in this work are a saw and a wooden vice, which has one of its chaps fixed, and the other moveable; which is open and shut by the foot, by means of a cord fastened to a treadle.

MARQUIS, a title of honour, next in dignity to that of duke, first given to those who commanded the marches, that is, the borders and frontiers of countries.

MARRIAGE, is the lawful conjunction of man and wife; it was also anciently used to denote the interest of bestowing a ward or a widow in marriage. Taking marriage in the light of a civil contract, the law treats it as it does all other contracts; allowing it to be good and valid in all cases where the parties, at the time of making it, were in the first place willing to contract; secondly, able to contract; and lastly, actually did contract in the proper forms and solemnities required by law. By several statutes, a penalty of one hundred pounds is inflicted for marrying any person without banns or license; but by 26 George II. c. 33, if any person shall solemnize matrimony without banns or license, obtained from some person having authority to grant the same, or in any other place than a church or chapel where banns have been usually published, unless by special license from the archbishop of Canterbury, he shall be guilty of felony, and transported for fourteen years. By the same statute it was enacted, that all such marriages were null and void; and much hardship thence resulted. Accordingly, in 1822 and 1823, the legislature was obliged again to interfere, and some marriages are now good, although the parties concerned in irregular celebration are liable to punishment.

Marriages, according to the laws of any other country, are valid in England, if duly solemnized in another country, as marriages in Scotland are. When a marriage is celebrated by license, affidavit must be made of the parties being above twenty-one, or of the consent of the father or guardian of the party. If the guardian or mother is beyond sea, or insane, the chancellor will proceed upon relation in their stead. Questions have lately arisen, whether this act applies to illegitimate children, and the civilians have held that it does. Marriages cannot be solemnized between persons within the Levitical degrees, but if solemnized they are not void till after sentence of the proper court. Promises of marriage, and precontracts, do not prevent the parties from lawfully marrying other persons; but an action lies for a breach of the contract. Marriage-brokage bonds are void in equity, and all contracts in restraint of marriage generally are void; but contracts and legacies upon condition not to marry any particular person, or without proper consent, are allowed, under various conditions and restrictions, some of which involve much difficulty. To marry a woman an heiress forcibly, is a capital felony by 3 Henry VII. c. 2, and 39 Elizabeth, c. 9. A wife cannot leave her husband. If she elope from him, she loses her dower, unless she returns and is reconciled.

MARROW, in Anatomy, a soft oleaginous substance contained in the cavity of the bones.

MARS, in Astronomy, is one of the planets in our system, the fourth in order from the sun, and consequently the next above our earth. The character by which it is represented is ♂, a rude representation of a man holding a sphere. This planet, which is known in the heavens by his red and fiery appearance, performs his revolution in his orbit in $686^{d}\ 23^{h}\ 30'\ 39''$, or 1·881 Julian years. His mean distance from the sun is 1·524, the distance of the earth being taken as unity, which makes his mean distance 142 millions of miles. The eccentricity of his orbit is ·093, the semiaxis major being 1. His mean longitude for 1800 was $2^{s}\ 4^{\circ}\ 7'\ 2''{\cdot}3$; the longitude of his perihelion being then $11^{s}\ 2^{\circ}\ 24'\ 23''{\cdot}9$; but the line of his apsides has an apparent motion according to the order of the signs of 1′ 5″·9 in a year, or 1° 51′ 3″·5 in a century. The orbit of Mars at the same time crossed the ecliptic in $1^{s}\ 18^{\circ}\ 1'\ 18''$, but the place of the nodes has an apparent motion in longitude, according to the order of the signs, of 26″·8 in a year, or 44′ 41″·5 in a century. The rotation on his axis is performed in $1^{d}\ 0^{h}\ 39'\ 21''\ 3$; and his axis is inclined to the ecliptic in an angle of 59° 41′ 49″·2. His mean diameter is equal to 4398 miles; consequently he is rather more than $\frac{1}{8}$th the size of our earth. His mass, compared with that of the sun considered as unity, is $\frac{1}{2546320}$. The proportion of light and heat received by him from the sun, is ·43; that received by the earth being considered as unity. He has a very dense but moderate atmosphere; and he is not accompanied by any satellite. As viewed from the earth, the motion of Mars appears sometimes retrograde. The mean arc which he describes in this case is 16° 12′; and its mean duration is about 73 days. This retrogradation commences, or finishes, when the planet is not more than 136° 48′ from the sun. Mars changes his phases somewhat in the same manner as the moon does from her first to her third quarter, according to his various positions with respect to the earth and the sun; but he never becomes cornicular, as the moon does when near her conjunctions. His mean apparent diameter is 9″·7; which augments in proportion as the planet approaches its opposition, when it is equal to 29″·2. His parallax is nearly double that of the sun. At the poles of this planet there has been observed bright spots, which are, however, variable in their size and figure; and from the observations of Dr. Herschel, it seems probable that they proceed from snows accumulated in his polar regions during their long winter, these having been observed to decrease and increase, according as they are directed to or from the sun. *See* ASTRONOMY.

MARSHAL, in its primary signification, an officer who has the command or care of horses; but it is now applied to officers who have very different employments, as earl-marshal, knight-marshal, or marshal of the king's house, &c.

MARSHAL *of the King's Bench*, an officer who has the custody of the King's Bench prison in Southwark.

MARSHAL *of the Exchequer*, an officer to whom that court commits the king's debtors.

MARSHALLING A COAT, in heraldry, is the disposal of several coats of arms belonging to distinct families, in one and the same escutcheon or shield, together with their ornaments, parts, and appurtenances.

MARSHALSEA COURT, is a court of record, originally instituted to hear and determine causes between the servants of the king's household, and others within the verge; and has jurisdiction within the verge of the court, and of pleas of trespass, where either party is of the king's family, and of all other actions personal, wherein both parties are the king's servants, but the court has also the power to try all personal actions, as debt, trespass, &c. between party and party, within the liberty, which extends twelve miles about Whitehall. The judges of this court are, the steward of the king's household, and knight marshal for the time being. It sits every week, so that judgment can be obtained in a fortnight or three weeks. It has jurisdiction of all debts above as well as below 40*s*. But causes of importance, such as debts above 20*l*. may be removed into the court of King's Bench or Common Pleas, by an *habeas corpus cum causa*.

MARSH MARIGOLD. *Caltha Palustris*. The flower buds, which are opening, are pickled, and are considered as a good substitute for capers.

MARTIN, BENJAMIN, a very eminent English artist, and mathematician, was born in 1704, but in 1782, in the 78th year of his age, he put a period to his existence. He was author of a great number of ingenious treatises on scientific subjects.

MASH, a drink given to a horse, made of half a peck of ground malt put into a pail, into which as much scalding-hot water is poured as will wet it very well: when that is done, stir it about, till by tasting you find it as sweet as honey; and when it has stood till it is lukewarm, it is to be given to the horse.

MASON, a person employed under the direction of an architect, in the raising of a stone building. The chief business of a mason is to make the mortar, raise the walls from the foundation to the top, with the necessary retreats and perpendiculars; to form the vaults, and employ the stones as delivered to him. When the stones are large, the business of hewing or cutting them belongs to the stone-cutters, though these are frequently confounded with masons: the ornaments of sculpture are performed by carvers in stone, or sculptors. The tools or implements principally used by them are, the square, level, plumb line, bevel, compass, hammer, chisel, mallet, saw, trowel, &c. *See* SQUARE, &c. Besides the common instruments used in the hand, they have likewise machines for raising of great burdens, and the conducting of large stones, the principal of which are the lever, pulley, wheel, crane, &c. *See* LEVER, &c.

MASONS, FREE AND ACCEPTED, a very ancient society, so called, either from some extraordinary knowledge of masonry they are supposed to be masters of, or because the first founders of the society were persons of that profession. The members are said to be admitted into the fraternity, by being put into possession of a number of secrets, called the mason's word.

MASONRY, in general the art of hewing or squaring stones, and cutting them level or perpendicular, for the uses of building; but in a more limited sense, masonry is the art of assembling and joining stones with mortar.

MAST, a long round piece of timber, raised perpendicularly on the keel of a ship, upon which are attached the yards, the sails, and the rigging, in order to their receiving the wind necessary for navigation. A mast, according to its length, is either formed of one single piece, which is called a pole mast, or composed of several pieces joined together, each of which retains the name of mast separately. A lower mast being the lowest, is accordingly so called. It is fixed in the ship by an apparatus, (see the articles HULK and SHEERS,) and the foot or keel of it rests in a block of timber called the *step*, which is fixed upon the keelson. A top mast is raised at the head or top of the lower mast through a cap, and supported by the trestle trees. It is composed of two strong bars of timber, supported by two prominences, which are as shoulders on the opposite sides of the masts, a little under its upper end; athwart these bars are fixed the cross trees, upon which the frame of the top is supported. Between the lower mast-head and the foremost of the cross trees, a square space remains vacant, the sides of which are bounded by the two trestle trees. Perpendicularly above this is the foremost hole in the cap, whose after hole is solidly fixed on the head of the lower mast. The top mast is erected by a tackle, whose effort is communicated from the head of the lower mast to the foot of the top mast, and the upper end of the latter is accordingly guided into, and conveyed up through the holes between the trestle trees and the cap as above mentioned; the machinery by which it is elevated, or, according to the sea phrase, swayed up, is fixed in the following manner: The top rope, passing through a block, which is hooked on one side of the cap, and afterwards through a hole furnished with a sheave or pulley on the lower end of the top mast, is again brought upwards on the other side of the mast, where it is at length fastened to an eye bolt in the cap, which is always on the side opposite to the top block. To the lower end of the top rope is fixed the top tackle, the effort of which being transmitted to the top rope, and thence to the heel of the top mast, necessarily lifts the latter upwards parallel to the lower mast. When the top mast is raised to its proper height, the lower end of it becomes firmly wedged in the square hole (above described) between the trestle trees. A bar of wood or iron, called the fid, is then thrust through a hole in the heel of it, across the trestle trees, by which the whole weight of the top mast is supported. See the articles CAP and TRESTLE TREES.

*Top Gallant* MAST, is a mast smaller than the preceding, and raised and secured to its head in the same manner.

*Top Gallant Royal* MAST, is sometimes a yet smaller mast, elevated through irons at the head of the top-gallant mast, but it is more generally a continuation of the latter above the rigging. It is then termed a pole top-gallant mast, to distinguish it from a stump top-gallant mast, which terminates just above the rigging.

*Main* MAST, the largest mast in a ship, and stands nearly in the middle between the stem and stern.

*Fore* MAST, is that which stands near the stem, and is next in size to the main mast.

*Mizzen* MAST, the smallest mast, and stands about half way between the main mast and the stern.

*Made* MAST, a mast built or composed of several pieces of timber, in contradistinction to one consisting of a single stick or piece. The counter mizzen, in large vessels and [illegible], is the stern.

*Rough* MAST, denotes a spar fit for making a mast. Besides the parts already mentioned in the construction of masts with respect to their length, the lower masts of the largest ships are composed of several pieces united into one body. As these are generally the most substantial parts of various tiers, a mast formed by this assemblage, is justly esteemed much stronger than one consisting of any single trunk, whose internal solidity may be very uncertain. The whole is secured with their sides or faces close to each other, by several strong hoops of iron, driven on the outside of the mast, where they remain at proper distances. The principal articles to be considered in equipping a ship with masts are, 1st. The number: 2d. Their situation in the vessel: and 3d. Their height above the water. The masts being used to extend the sails by means of their yards, it is evident, that if their number were multiplied beyond what is necessary, the yards must be extremely short, that they may not entangle each other in working the ship, and by consequence their sails will be very narrow, and receive a small portion of wind. If, on the contrary, there is not a sufficient number of masts in the vessel, the yards will be too large and heavy, and cannot be managed without difficulty. There is a mean between these extremes, which experience and the general practice of the sea have determined, by which it appears, that in large ships every advantage of sailing is retained by three masts and a bowsprit.

Among the ancient Grecians, every ship had several masts: we are nevertheless informed by Aristotle, that at first there was only one mast, which being fixed in the middle of the ship, the hole into which the foot of it was inserted they called *μεσοδμη*, in Latin *modius*, and in English the step. The parts of the mast were these: *πτερνα*, or the foot; *λωας*, to which the sail was fixed; *καρκησιον*, the pulley by which the ropes were turned round; *θωρακιον*, built in the manner of a turret, for soldiers to stand upon, and cast their darts. Above this was a piece of wood called *ικριον*, on the extremity of which hung a riband, which was in continual motion, turning round with the wind, and termed in English the *vane*. With regard to the moderns, all ships, properly so called, are, as already observed, furnished with three masts. Those which have only two or one mast are not called ships by seamen, but vary their names according to the method of rigging. Of two masts, there are snows, brigs, bilanders, ketches, busses, schooners, and hermaphrodites, among the English. Among the Spaniards and Italians, settees, barco-longas, feluccas, &c. Those of one mast are sloops, tartans, bean-cods, shallops, &c.

The most advantageous position of the masts is undoubtedly that from whence there results an equilibrium between the resistance of the water on the body of the ship on one part, and of the direction of their effort on the other. By every other position this equilibrium is destroyed, and the greatest effort of the masts will operate to turn the ship horizontally about its direction, a circumstance which retards her velocity. It is counterbalanced indeed by the helm, but the same inconvenience still continues; for the force of the wind having the resistance of the helm to overcome, is not entirely employed to push the vessel forward. The axis of the resistance of the water should then be previously determined, to discover the place of the main mast, in order to suspend the efforts of the water equally, and place the other masts so as that their particular direction will coincide with that of the main mast. The whole of this would be capable of a solution, if the figure of the vessel were regular, because the point about which the resistance of the water would be in equilibrium, might be discovered by calculation; but when the real figure of the ship is considered, these flattering ideas will instantly vanish. This observation induced M. Saverien to employ a mechanical method to discover the axis of resistance of the water, which he apprehended might be used with success. The exact height of the masts in proportion to the form and size of the ship, remains yet a problem to be determined. The more the masts are elevated above the centre of gravity, the greater will be the surface of the sail which they are enabled to present to the wind; so far an additional height seems to be advantageous. But this advantage is diminished by the circular movement of the mast, which operates to make the vessel stoop to its effort; and this inclination is increased in proportion to the additional height of the masts; an inconvenience which it is necessary to guard against: thus what is gained upon one hand is lost upon the other. To reconcile these differences, it is certain that the height of the mast ought to be determined by the inclination of the vessel, and that the point of her greatest inclination should be the turn of this height above the centre of gravity. See the article TRIM. With regard to the general practice of determining the height of the masts, according to the different rates of the ships in the royal navy, see also the article SAIL. In order to secure the masts, and counterbalance the strain they receive from the effort of the sails impressed by the wind and the agitation of the ship at sea, they are suspended by several strong ropes extended from their upper ends to the outside of the vessel, called shrouds, (see that article.) They are further supported by other ropes, stretched from their heads towards the forepart of the vessel. See the article RIGGING. In the British navy, masts are proportioned to the extreme breadth of the ship from out to out.

The main and fore mast in all ships down to 60 guns, one inch diameter to every yard in length. For 50 and 40 guns, $\frac{27}{28}$th of an inch diameter to one yard in length. For 24 guns, $\frac{12}{13}$ths of an inch in diameter to one yard in length. All top masts are nine-tenths of an inch in diameter to one yard in length. The fore top mast as large as the main-top mast. The top-gallant mast one inch to a yard. The mizzen mast $\frac{15}{22}$ of an inch to one yard in length. The mizzen top-mast five-sixths of an inch to one yard in length. The bowsprit an inch and a half to one yard. The jibboom seven-eighths of an inch to a yard. The proportion for masting ships in the merchant's service is generally regulated by the judgment and experience of the commander.

*General Proportion for the Length of Masts.*

| | | | |
|---|---|---|---|
| 1000 : breadth in feet :: | 748 : | Main mast in yards | 100 *Guns.* |
| | 756 : | | 90 |
| | 753 . | | 80 |
| | 741 : | | 70 and 60. |
| | 740 : | | 50 |
| | 747 : | | 44 |
| | 700 : | | 24 |
| 1000 : main mast :: ... | 895 :<br>901 : | fore mast ........ | 100, 90, 80, and all the rest. |
| 1000 : main mast ::.... | 870 :<br>866 : | mizzen mast...... | 100, 90, 80, and all the rest. |
| 1000 : main mast ::.... | 640 :<br>613 . | bowsprit ......... | 100, 90, 80, and all the rest. |
| 1000 : main mast ::.... | 600<br>605 :<br>613 : | main top mast .... | 100, 90, 80, 70, 60, 50, 44, 24. |
| 1000 : main top mast :: | 950 :<br>919 : | fore top mast...... | 100, 90, 80, and all the rest. |
| 1000 : main top mast :: | 710 .<br>717 | mizzen top mast... | 100, 90, 80, and all the rest. |
| 1000 : main top mast :: | 480 :<br>508 . | main top gall. mast | 100, 90, 80, and all the rest. |
| 1000 : fore top mast :: | 480 :<br>505 : | fore top gall. mast | 100, 90, 80, and all the rest. |

*The Dimensions of Masts for East India Ships are,*

| | Length in Feet. | Diameter in Inches. |
|---|---|---|
| *Main Mast,* ........... | 80 | .......... 24½ |
| Top Mast, ............ | 50 | .......... 15 |
| Top gallant Mast, ..... | 28 | .......... 8 |
| *Fore Mast,* ............ | 72 | .......... 24 |
| Top Mast, ............ | 48 | .......... 16 |
| Top-gallant Mast,...... | 25 | .......... 7½ |
| *Mizzen Mast,*.......... | 70 | .......... 17 |
| Top Mast,............ | 36 | .......... 10 |
| Bowsprit,............ | 59 | .......... 25 |

*Armed* MAST, is a mast that is made of more than one tree.

*To* MAST *a Ship*, to hoist her masts into her by means of a sheer, or of a sheer hulk. See these articles.

*Spending a* MAST, is when it is broken by foul weather.

*Springing a* MAST, is when it is cracked in any place.

*Over Masted*, or *Taut Masted*: is said of a ship whose masts are too tall or too heavy, which makes her lie too much down by the wind, and labour too much a-hull.

*Under Masted*, or *Low Masted Ships*, are such whose masts on the contrary are too short or light; in which case she cannot bear so great a sail as should give her true way.

*Clint's Ballanced* MASTS *for Sailing Vessels.*—The object of this invention is, by having the mast, rigging, &c. placed in a ballasted cassoon or box of a semicircular shape, suspended fore and aft on pins, &c. in two deck beams; that the mast, &c. shall alone be acted on by the wind, and (as shewn by the figure,) leave the vessel itself perfectly upright, when close-hauled upon a wind.

Explanation of the figures. Fig. 1, *a*, a section of the hull of the vessel, *b* a section of the swinging cassoon, with the stays, pennants, &c. fastened to it, and the box containing the ballast; *c*, the point of suspension on the deck beams. Fig. 2 is a plan of the sailing boat, containing the cassoon *b*, and swinging upon the pivots *c c*. Mechanical skill will be requisite in the construction of the parts for strength, to sustain the ballast: pins of three inches diameter would sustain about thirty or forty tons. The forestay is to be hooked to the stern head.

Fig 1.

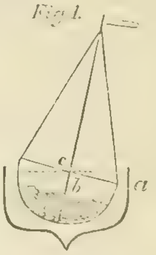
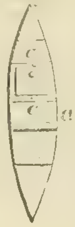
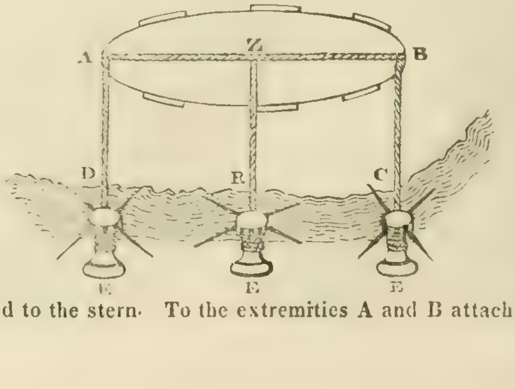


Fig. 2



The advantages proposed by Mr. Clint by this construction are *first*, perfect safety; as he considers it impossible that a vessel on this construction could capsize. *Secondly*, the vessel being always upright, is constantly on what is termed her *lines*, and is always in her *trim*; whereby she will sail faster, and go better to windward. *Thirdly*, the support for the mast, &c. being within the vessel, the width of beam may be diminished to one half, whereby the vessel will acquire length, and go faster. *Fourthly*, the ballast being *suspended in the air* is of more effect than ballast placed in the bottom; the latter being identified with the vessel, and the water loses as much of its weight as its specific gravity; while the former being independent of the water, and maintaining all its weights, a much smaller quantity will be required to steady the mast, and the vessel itself requiring none, a great degree of buoyancy is obtained. The truth of this position may be ascertained by holding in the hand a weight in the air, and holding it in the water. A vessel on this principle has been constructed, of the following dimensions:—Length 25 feet, breadth 5 do. depth 2½ do.; space for the cassoon 5 feet square, cassoon a good fit to the same size. She was rigged with one mast of nineteen feet, carrying a gaff and foresail, and containing fifty yards of cloth. To those conversant with sailing, this quantity of rigging must appear very extraordinary; but her capacity to carry it results from the principle mentioned in the position. This invention is intended only for such vessels as are not employed in the carrying of cargoes, of which class are revenue cutters, pleasure and pilot boats, cartels, nor is it intended for vessels above seventy tons, which may have the box decked in.

When the vessel is launched before the places of the masts are determined, extend a rope A B, in the following figure, from the head to the stern. To the extremities A and B attach two



other ropes AD, BC, and apply to the other ends of these ropes two mechanical powers, to draw the ship according to the direction BC, parallel to itself. The whole being thus disposed, let a moveable tube Z, fixed upon the rope AB, have another rope ZR attached to it, whose other end communicates with a mechanical power R equal to the two other powers D and C. This last being applied to the same vessel, in such manner as to take off the effects of the two others by sliding upon the rope AB, so as to discover some point Z, by the parallelism of the ropes AD, BC, feebly extended with the rope ZR; the line ZR will be the axis of the equilibrium of the water's resistance, and by consequence the main mast should be planted in the point Z. The figures E, E, E, are three windlasses on the shore, by which this experiment is applied. With regard to the situation of the other masts, it is necessary in the same manner to discover two points; so that the direction of the two mechanical powers operating, will be parallel to the axis of resistance RZ, already found.

MASTER OF ARTS, is the first degree taken up in foreign universities, and for the most part in those of Scotland; but the second in Oxford and Cambridge, candidates not being admitted to that honour till they have studied seven years in the university.

MASTER *in Chancery*. The masters in Chancery are assistants to the Lord Chancellor and Master of the Rolls; of these there are some ordinary and others extraordinary: the masters in ordinary are twelve in number; some of whom sit in court every day during the term, and have referred to them interlocutory orders for stating accounts, and computing damages, and the like; and they also administer oaths, take affidavits, and acknowledgments of deeds and recognizances. The masters extraordinary are appointed to act in the country, beyond ten miles' distance from London.

MASTER *of the Faculties*, an officer under the archbishop of Canterbury, who grants licenses and dispensations.

MASTER *of the Horse*, a great officer of the crown, who orders all matters relating to the king's stables, races, breed of horses, &c.

MASTER *of the Ordnance*, a great officer who has the chief command of the king's ordnance and artillery.

MASTER *of the Rolls*, a patent officer for life, who has the custody of the rolls of parliament, and patents which pass the great seal, and of the records of chancery, &c. In absence of the chancellor, he sits as judge in the court of chancery; at other times he hears causes in the rolls chapel, and makes orders; he hath a writ of summons to parliament.

MASTER *of a Ship*, the same with captain in a merchantman; but in a king's ship he is an officer who inspects the provisions and stores, takes care of the rigging and of the ballast, and gives directions for stowing the hold; and navigates the ship under the directions of his superior officer.

MASTER *at Arms*, in a king's ship, an officer who daily by turns, as the captain appoints, is to exercise the petty officers, and ship's company, to place and relieve sentinels, to see the candles and fire put out according to the captain's orders, to take care the small arms are kept in good order, and to observe the directions of the lieutenant at arms.

MASTER *of the Temple*, since the dissolution of the order of the Templars, the spiritual guide and master of the Temple is so called, which was the denomination of the founder and his successors.

MASTER *of the Wardrobe*, an officer under the lord chamberlain, who has the care of the royal robes, &c.

MASTERS and SERVANTS. In London and other places, the mode of hiring is by what is commonly called a month's warning or a month's wages; that is, the parties agree to separate on either of them giving to the other a month's notice for that purpose, or, in lieu thereof, the party requiring the separation to pay or give up a month's wages. But if the hiring of a servant be general, without any particular time specified, it will be construed to be a hiring for a year certain; and in this case, if the servant departs before the year, he forfeits all his wages. And where a servant is hired for one year certain, and so from year to year as long as both parties shall agree, and the servant enter upon the second year, he must serve out that year, and is not merely a servant at will after the first year. If a woman servant marry, she must nevertheless serve out her term. If a servant be disabled in his master's service, by an injury received through another's default, the master may recover damages for loss of his service. And a master may not only maintain an action against any one who entices away his servant, but also against his servant; and if, without any enticement, a servant leaves his master without just cause, an action will lie against another, who retains him with a knowledge of such departure. A master has a right to expect and exact fidelity and obedience in all his lawful commands; and to enforce this, he may correct his servant in a reasonable manner. In defence of his master, a servant may justify assaulting another, and though death should ensue, it is not murder, in case of any unlawful attack upon his master's person or property. Acts of the servant are in many instances deemed acts of the master; and he is answerable for them, when they are pursuant to his authority. If a servant commit an act of trespass by command or encouragement of his master, the master will be answerable. But in so doing, his servant is not excused, as he is bound to obey the master in such things only as are honest and lawful. If a servant of an innkeeper robs his master's guest, the master is bound to make good the loss. Also, if a waiter at an inn sell a man bad wine, by which his health is impaired, an action will lie against the master. In like manner, if a servant be frequently permitted to do a thing by the tacit consent of his master, the master will be liable. If a servant is usually sent upon trust with any tradesman, and he takes goods in the name of his master, upon his own account, the master must pay for them; and also, if he is sent sometimes on trust, and at other times with money. But if a man usually deals with tradesmen himself, or constantly pays them their money, he is not answerable for what his servant may take up in his name. So it is, if the master never had any personal dealings with the tradesman, but the contracts have always been between the servant and the tradesman, and the master has regularly given his servant money for payment of every thing had on his account, the master shall not be charged. Or if a person forbid his tradesman to trust his servant on his account, and he continues to purchase upon credit, he is not liable. The act of a servant, though he has quitted his master's service, has been held to be binding upon the master, by reason of the former credit given him on his master's account, and its not being known to the party trusting that he was discharged. The master is also answerable for any injury arising by the fault or neglect of his servant, when executing his master's business. If a smith's servant lame a horse whilst shoeing him, or the servant of a surgeon make a wound worse, an action for damages will lie against the master, and not against the servant. A master is likewise chargeable for any nuisance occasioned by his servants, to the damage or annoyance of any individual or the common nuisance of his majesty's subjects. A servant is not answerable to his master for any loss which may happen without his wilful neglect, but if he be guilty of fraud or gross negligence, an action will lie against him by his master. A master is not liable in trespass for the wilful act of his servant, as by driving his master's carriage against another, without the direction or assent of his master, no person being in the carriage when this act was done. But he is liable to answer for any damage arising to another from the negligence or unskilfulness of his servant acting in his employ, as for negligently driving against another.

MASTICATION, in Medicine, the action of chewing, or of agitating the solid parts of our food between the teeth, by means of the motion of the jaws, the tongue, and the lips, whereby it is broken into small pieces, impregnated with saliva, and so fitted for deglutition and a more easy digestion.

MASTICH, in the materia medica, when pure is in the form of little round drops or tears of a very pale amber. When slightly warmed, this resin has a faint and rather pleasant odour, which becomes stronger and more grateful when it is melted. In Turkey, mastich is in great request among women as a masticatory. In other countries it is employed medicinally in fumigations; and by painters and other artists, in the composition of the tougher kinds of varnishes.

MATCH, a kind of rope slightly twisted, and prepared to retain fire for the uses of artillery, mines, fireworks, &c.

**MATCHING**, in the wine trade, the preparing vessels to preserve wines and other liquors, without their growing sour or vapid. The method of doing it as follows :—Melt brimstone in an iron ladle, and when thoroughly melted dip into it slips of coarse linen cloth ; take these out, and let them cool ; this the wine coopers call a match. Take one of these matches, set one end of it on fire, and put it into the bung-hole of a cask ; stop it loosely, and thus suffer the match to burn nearly out ; then drive in the bung tight, and set the cask aside for an hour or two. At the end of this time examine the cask, and you will find that the sulphur has communicated a violent pungent and suffocating scent to the cask, with a considerable degree of acidity, which is the gas and acid spirit of the sulphur. The cask may after this be filled with a small wine which has scarce done its fermentation; and bunging it down tight it will be kept good, and will soon clarify : this is a common and very useful method, for many poor wines could scarce be kept potable even a few months without it.

**MATERIA MEDICA.** The materia medica includes all those substances which may contribute to the restoration of health.

**MATHEMATICS**, from *Mathema*, a science. The science which contemplates whatever is capable of being numbered or measured. Mathematics are commonly distinguished into speculative and practical, pure and mixed. *Speculative Mathematics*, is that which barely considers the properties of things ; and *Practical Mathematics*, that which applies the knowledge of those properties to some uses in life. *Pure Mathematics* is that branch which considers quantity abstractedly, and without any relation to matter or bodies, as Arithmetic and Geometry. *Mixed Mathematics*, considers quantity as subsisting in material being ; for instance, length in a pole, depth in a river, height in a tower, &c. *Pure Mathematics*, again, either considers quantity as abstract or discrete, these words are synonymous in this sense, and so computable as Arithmetic ; or as concrete, and so measurable as Geometry. *Mixed Mathematics* is very extensive, and is distinguished by various names, according to the different subjects it considers, and the different views in which it is taken, such as astronomy, geography, optics, hydrostatics, navigation, &c.

**MATRICARIA** Parthenium. *Common wild Feverfew. The Land Flowers.*—Simon Pauli relates, that he has experienced happy effects from it in obstructions of the uterine evacuation. I have often seen, says he, from the use of a decoction of matricaria and chamomile flowers with a little mugwort, hysteric patients instantly relieved, and the patient from a lethartic state brought as it were to life again. Matricaria is likewise recommended in sundry other disorders, as a warm stimulating bitter : all that bitters and carminatives can do, says Geoffroy, may be expected in this. It is undoubtedly a medicine of some use in these cases, but not perhaps equal to chamomile flowers alone, with which the matricaria agrees in sensible qualities, except in being weaker.

**MATTER**, in Philosophy, whatever is extended, and capable of making resistance ; hence, because all bodies, whether solid or fluid, are extended and do resist, we conclude that they are made up of matter. That matter is one and the same thing in all bodies, and that all the variety we observe arises from the various forms and shapes it puts on, seems very probable, from a general observation of nature in the generation and destruction of bodies : thus, water rarefied by heat becomes vapour ; a great collection of which forms clouds ; these condensed descend in hail or rain ; part of this collected on the earth constitutes rivers ; another part mixing with the earth, enters into the roots of plants, and expands itself into various species of vegetables. In each vegetable it appears in one shape in the root, another in the stalk, another in the flowers, &c. Hence various bodies proceed ; from the oak, houses, ships, &c. ; from hemp and flax we have thread ; thence our various kinds of linen ; these degenerate into rags, which receive from the mill the various forms of paper, &c.

According to Newton, it seems probable that God in the beginning formed matter into solid, massy, impenetrable, moveable particles, or atoms, of such sizes and figures, and with such other properties, and in such proportion to space, as most conduced to the end for which he formed them ; these primitive particles being solids, are incomparably harder than any porous bodies compounded of them, no ordinary power being able to divide what God himself made one in the first creation. While these particles continue entire, they may compose bodies of the same nature and texture in all ages ; but should they wear away, or break in pieces, the nature of things depending on them may be changed. Water and earth composed of old worn particles and fragments of particles, would not be of the same nature and texture now, with water and earth composed of entire particles in the beginning ; and therefore, that nature may be lasting, the changes of corporeal things are to be placed only in the various separations and new associations of motions of these permanent particles, compound bodies being apt to break, not in the midst of solid particles, but where those particles are laid together and only touch in a few minutes. Dr. Berkeley argues against the existence of matter itself, and endeavours to prove that it has no existence out of the mind. Some late philosophers have advanced a new hypothesis concerning the nature and essential properties of matter, as Boscovich, in his "Theoria Philosophiæ Naturalis;" who supposes that matter is not impenetrable, but consists of physical points only, endued with powers of attraction and repulsion, taking place at different distances ; that it is surrounded with various spheres of attraction and repulsion, in the same manner as solid matter is supposed to be. Provided therefore any body move with a sufficient degree of velocity, or have a sufficient momentum to overcome any power of repulsion that it may meet with, it will find no difficulty in making its way through any body whatever. If the velocity of such body in motion be sufficiently great, Boscovich contends that the particles of any body through which it passes, will not even be moved out of their place by it. With a degree of velocity something less than this, they will be considerably agitated, and ignition might perhaps be the consequence, though the progress of the body in motion would not be sensibly interrupted ; and with a still less momentum, it might not pass at all. Dr. Priestley, and some others of our own country, entertained the same opinion. In conformity to this hypothesis Priestley maintains that matter is not that inert substance that it has been supposed to be ; that powers of attraction or repulsion are necessary to its being ; and that no part of it appears impenetrable to other parts. Accordingly, he defines matter to be a substance possessed of the property of extension, and of powers of attraction or repulsion, not distinct from matter, and foreign to it, but absolutely essential to its nature and being ; so that when bodies are divested of these powers they become nothing. In another place, Priestley has given a somewhat different account of matter ; according to which it is only a number of centres of attraction and repulsion, or, more properly, of centres not divisible, to which divine agency is directed ; and as sensation and thought are not incompatible with these powers, solidity or impenetrability, and consequently a *vis inertiæ*, only having been thought repugnant to them, he maintains that we have no reason to suppose that there are in man two substances absolutely distinct from each other. But Dr. Price, in a correspondence with Dr. Priestley, published under the title of "A Free Discussion of the Doctrines of Materialism and Philosphical Necessity," 1778, suggested a variety of unanswerable objections against this hypothesis of the penetrability of matter, and against the conclusions that are drawn from it. The *vis inertiæ* of matter is the foundation of all that is demonstrated by natural philosophy concerning the laws of the collision of bodies. This is the foundation of Newton's philosophy, and especially of his three laws of motion. Solid matter has the power of acting on other matter by impulse ; but unsolid matter cannot act at all by impulse ; and this is the only way in which it is capable of acting by any action that is properly its own. If it be said that one particle of matter can act upon another without contact and impulse, or that matter can, by its own proper agency, attract or repel other matter which is at a distance from it, then a maxim hitherto universally received must be false, that "Nothing can act where it is not." Newton, in his letters to Bentley, calls the notion that matter possesses an innate power of attraction, or that it can act upon matter at a distance, and attract and repel it by its own agency, an absurdity into which he thought no one could possibly fall. And in another place he expressly disclaims the notion of innate gravity, and has taken pains to shew that he did not take it to be an essential property of bodies. By the same kind of reasoning pursued, it must appear that matter has not the power of attracting and repelling; that this power is the power of some foreign cause, acting upon matter according to stated laws; and consequently that attraction and repulsion not being actions, much less inherit qualities, of matter; as such, it ought not to be defined by them. And if matter has no other property, as Dr. Priestley asserts, than the power of attracting and repelling, it must be a non-entity; because this is a property that cannot belong to it. Besides, all power is the power of something, and yet if matter is nothing the very idea of it is a contradiction. If matter be not solid extension, what can it be more than mere extension. Farther, matter that is not solid, is the same with pore; and therefore it cannot possess what philosophers mean by the momentum or force of bodies, which is always in proportion to the quantity of matter in bodies void of pore.

**MATRIX**, or *Mother Earth*, the stone in which metallic ores are found enveloped.

**MATROSSES**, are soldiers in the train of artillery, who are next to the gunners, and assist them in loading, firing, and spunging the great guns.

**MAUNDAY** THURSDAY, is the Thursday in the passion week; called Munday or Mandate Thursday, from the command which our Saviour gave his apostles to commemorate him in the Lord's Supper, which he this day instituted; or from the new commandment that he gave them, to love one another, after he had washed their feet in token of his love to them.

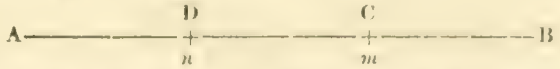
**MAUPERTUIS**, PETER LOUIS MORCEAU DE, a celebrated French mathematician and philosopher, was born at Malo, in 1698, and was there privately educated, till he attained his 16th year, when he was placed under the celebrated professor of philosophy, M. Le Bland, in the college of La Marche, at Paris; while M. Guisnee, of the Academy of Sciences, was his instructor in mathematics. In 1723 he became a member of the French Academy, and five years after a fellow of the Royal Society of London. In 1736 he was sent, with other academicians, to the North, to determine the figure of the earth, which service they performed with reputation. At the invitation of the Prince of Prussia, afterwards Frederic the Great, he went to Berlin, and was appointed president and director of the Academy there. He died at Basil, in 1759.

**MAXILLA.** *See* ANATOMY.

**MAXIM**, an established proposition or principle, in which sense it denotes much the same with axiom. *See* AXIOM.

**MAXIMA** ET **MINIMA**, in Analysis and Geometry, are the greatest and least value of a variable quantity; and the method of finding these greatest and least values, is called the *Methodus de Maximis et Minimis*, which forms one of the most interesting inquiries in the modern analysis. This subject was considered geometrically by some of the most ancient mathematicians, particularly by Apollonius, in the 5th book of his Conics, and there are still a few problems of this kind, which succeed better by the geometrical than by the analytical method; their number, however, is very limited, compared with those which may be elegantly formed with analysis. The method of maxima et minima, according to the analytical doctrine, first arose at the beginning of the seventeenth century, after the invention of Des Cartes for expressing the properties of curve lines by means of algebraical equations, and classing them into different orders according to the degree of the equation which expressed the relation between the abscis and ordinate. Besides the method of Des Cartes, we have also those of Fermat, Hudde, Huygens, Sluze, and some others, which are now all supplanted by the general and elegant method of fluxions.

**MAXIMUM**, in Mathematics, denotes the greatest quantity attainable in a given case. If a quantity conceived to be generated by motion, increases or decreases till it arrives at a certain magnitude or position, and then, on the contrary, grows less or greater, and it be required to determine the said magnitude or position, the question is called a problem de maximis et minimis. Thus let a point $m$ move uniformly in a right line, from A towards B, and let another point $n$ move after it, with a velocity either increasing or decreasing, but so that it may at a certain position, D, become equal to that of the former point $m$, moving uniformly.



This being premised, let the motion of $n$ be first considered as an increasing one; in which case the distance of $n$ behind $m$ will continually increase, till the two points arrive at the contemporary positions C and D; but afterwards it will again decrease; for the motion of $n$ till then being slower than at D, it is also slower than that of the preceding point $m$, (by the hypothesis,) but becoming quicker afterwards than that of $m$, the distance $mn$ (as has been already said) will again decrease, and therefore as a maximum, or the greatest all, when the celerities of the two points are equal to each other. But if $n$ arrives at D with a decreasing celerity, then its motion being first swifter, and afterwards slower than that of $m$, the distance of $mn$ will first decrease and then increase, and therefore is a minimum, or the least of all, in the forementioned circumstance. Since then the distance $mn$ is a maximum or a minimum, when the velocities of $m$ and $n$ are equal, or when the distance increases as fast through the motion of $m$, as it decreases by that of $n$, its fluxion at that instant is evidently equal to nothing. Therefore as the points $m$ and $n$ may be conceived such that their distance $mn$ may express the measure of any variable quantity whatever, it follows, that the fluxion of any variable quantity whatever, when a maximum or a minimum, is equal to nothing. The rule therefore to determine any flowing quantity in an equation proposed, to an extreme value, is: having put the equation into fluxions, let the fluxion of that quantity whose extreme value is sought, be supposed equal to nothing; by which means all those members of the equation in which it is found will vanish, and the remaining ones will give the determination of the maximum or minimum required. *See* FLUXIONS.

**MAY.** Reckoning from January, this is the fifth month in our year; or the third, if we begin, as the ancient Romans did, with March. By Romulus it was called *Maius*, out of respect to the senators and nobles of his city. Some, however, have thought that the name is derived from *Maia*, the mother of Mercury, to whom sacrifices were offered on the first day of this month. May was supposed by the ancients to be under the immediate protection of Apollo. In it they kept the festival of *Bona Dea;* also that of the goblins called *Lemuria*, and the ceremony of the expulsion of the kings. In this month the sun enters Gemini, the earth teems with vegetative life, the trees are adorned with blossoms, and the gardens are perfumed with the fragrance of flowers.——The Kalendar of Animated nature for May, round London, brings the cuckoo and turtle-dove, the glow-worm, and the fern owl, or goatsucker.—In Vegetable nature, the lily of the valley, the tulip-tree, the oak, ash, sweet chestnut, barberry, and lime trees flower and blossom. Rye is now in the ear.—In the Kitchen garden, sow, protect, propagate, plant, transplant, attend to routine culture, and destroy insects and vermin. In the hardy fruit department, plant, plune, and attend to routine culture. In the culinary hothouse department attend to glass-casing, the pinery, and forcing department. Much is to be done in the flower garden, open ground and hot-house departments; as also in the pleasure ground and shrubbery. Fell old oaks and other barking trees, and prune oaks, because the wood heals quicker while the sap is flowing.—Of fish we have the same kinds in season this month as in April, which see; so also of meat, and poultry. Vegetables are more abundant, and to our winter stores of fruits there are now added strawberries, cherries, melons, gooseberries, and currants.

MAY *Weed*, in Botany, is a troublesome weed, which resembles wild chamomile. It is a trailing perennial plant, the branches of which put forth roots at every joint. By these means, and by scattering its seeds in the fields long before the corn is ripe, it multiplies without the possibility of prevention. It flowers in May, and from this circumstance derives its name. It is chiefly extirpated by summer fallowing, and by burning the roots collected by good harrowing. Many other weeds, together with various fruits, flowers, and natural productions bear the name of May, from their appearing during this month in the greatest state of perfection.

MAYER, TOBIAS, a German astronomer and mechanician, was born at Manpach, in Wirtemberg, in the year 1723; and in 1751 he was nominated mathematical professor at the university of Gottingen, and soon after was admitted a member of the Royal Society in that town. From this time every year of his life was distinguished by discoveries in geometry and astronomy. He invented many useful instruments; he applied himself to study the theory of the moon; he extended his observations to the planet Mars and the fixed stars, determining the places of the latter, and ascertaining that they possess a certain degree of motion relative to their respective systems. Towards the close of his short life the magnetic needle engaged his attention, to which he assigned more certain laws than those before received. To all his pursuits he applied with such indefatigable assiduity, that he died literally worn out with labour, in 1762, at the age of thirty-nine years.

MEAD, a wholesome, agreeable liquor, prepared with honey and water. One of the best methods of preparing mead is as follows:—Into twelve gallons of water put the whites of six eggs; mixing these well together, and to the mixture adding twenty pounds of honey. Let the liquor boil an hour; and when boiled, add cinnamon, ginger, cloves, mace, and rosemary. As soon as it is cold, put a spoonful of yeast to it, and turn it up, keeping the vessel filled as it works; when it has done working, stop it up close; and, when fine, bottle it off for use. The author of the Dictionary of Chemistry directs to choose the whitest, purest, and best tasted honey, and to put it into a kettle with more than its weight of water: a part of this liquor must be evaporated by boiling, and the liquor scummed, till its consistence is such, that a fresh egg shall be supported on its surface without sinking more than half its thickness into the liquor; then the liquor is to be strained and poured through a funnel into a barrel; this barrel, which ought to be nearly full, must be exposed to a heat as equable as possible, from 20 to 27 or 28 degrees of Mr. Reaumur's thermometer, taking care that the bung-hole be slightly covered, but not closed. The phenomena of the spirituous fermentation will appear in this liquor, and will subsist during two or three months, according to the degree of heat; after which they will diminish and cease. During this fermentation, the barrel must be filled up occasionally with more of the same kind of liquor of honey, some of which ought to be kept apart, on purpose to replace the liquor which flows out of the barrel in froth. When the fermentation ceases, and the liquor has become very vinous, the barrel is then to be put into a cellar, and well closed; a year afterwards, the mead will be fit to be put into bottles. Mead is a liquor of very ancient use in Britain. *See* FEAST.

MEAD, *Dr. Richard*, a celebrated English physician, was born at Stepney near London, where his father, the Rev. Mr. Matthew Mead, had been one of the two ministers of that parish; but in 1662 was ejected for nonconformity, but continued to preach at Stepney till his death. As Mr. Mead had a handsome fortune, he bestowed a liberal education upon 13 children, of whom Richard was the eleventh; and for that purpose kept a private tutor in his house.

MEADOW, in its general signification, means pasture or grass lands, annually mown for hay; but it is more particularly applied to lands that are so low as to be too moist for cattle to graze upon them in winter without spoiling the sward.

MEADOW-SWEET. *Spiræa Filipendula.*—The roots of this, in Sweden, are ground and made into bread.

MEAL, the flour of grain. The colour and weight are the two things which denote the value of meal or flour; the whiter and heavier, other things being alike, the better it always is.

MEAN, in general, denotes the middle between two extremes: thus we say, the mean distance, mean proportion, &c.

MEAN, *Arithmetical*, is half the sum of the two extremes, as 4 is the arithmetical mean between 2 and 6; for $\frac{2+6}{2} = 4$.

MEAN, *Geometrical*, is the square root of the rectangle, or product of the two extremes, thus, $\sqrt{1 \times 9} = \sqrt[2]{9} = 3$. To find two mean proportionals between two extremes: multiply each extreme by the square of the other, then extract the cube root out of each product, and the two roots will be the mean proportionals required. Required two proportionals between 2 and 16, $\overline{2 \times 2} \times 16 = 64$, and $\sqrt[3]{64} = 4$. Again, $\sqrt[3]{2 \times 16^2} = \sqrt[3]{512} = 8$. 4 and 8, therefore, are the two mean proportionals sought.

*Harmonical* MEAN, is double a fourth proportional to the two extremes themselves *a* and *b*. Or it is the reciprocal of the arithmetical mean between the reciprocals of the given extremes.

MEASURE, among Botanists. In describing the parts of plants, Tournefort introduced a geometrical scale, which many of his followers have retained. They measured every part of the plant; and the essence of the description consisted in an accurate mensuration of the whole. As the parts of plants, however, are liable to variation in no circumstance so much as that of dimension, Linnæus very rarely admits any other mensuration than that arising from the respective length and breadth of the parts compared together. In cases that require actual mensuration, the same author recommends, in lieu of Tournefort's artificial scale, the following natural scale of the human body, the sum of the extremes, and which he thinks is much more convenient, and equally accurate. The scale in question consists of 11 degrees, which are as follow: 1. A hair's breadth, or the diameter of a hair (*capillus*). 2. A line (*linea*), the breadth of the crescent or white appearance at the root of the finger, (not thumb, measured from the skin towards the body of the nail; a line is equal to 12 hairbreadths, and is the 12th part of a Parisian inch. 3. A nail (*unguis*), the length of a finger nail; equal to six lines, or half a Parisian inch. 4. A thumb (*pollex*), the length of the first or outermost joint of the thumb; equal to a Parisian inch. 5. A palm (*palmus*), the breadth of the palm exclusive of the thumb; equal to three Parisian inches. 6. A span (*spithama*), the distance between the extremity of the thumb and that of the first finger when extended; equal to seven Parisian inches. 7. A great span (*dodrans*), the distance between the extremity of the thumb and that of the little finger when extended, equal to nine inches. 8. A foot (*pes*), measuring from the elbow to the basis of the thumb; equal to 12 Parisian inches. 9. A cubit (*cubitus*), from the elbow to the extremity of the middle finger; equal to 17 inches. 10. An arm length (*brachium*), from the armpit to the extremity of the middle finger, equal to 24 Parisian inches, or two feet. 11. A fathom (*orgya*), the measure of the human stature; the distance between the extremity of the two middle fingers, when the arms are extended; equal, where greatest, to six feet.

MEASURE *of an Angle*, is an arch described from the vertex in any place between its legs. Hence angles are distinguished by the ratio of the arches, described from the vertex between the legs to the peripheries. Angles then are distinguished by those arches; and the arches are distinguished by their ratio to the periphery. Thus an angle is said to be so many degrees as are there in the said arch.

MEASURE *of a Solid*, is a cube whose side is an inch, a foot, or a yard, or any other determinate length. In geometry, it is a cubic perch, divided into cubic feet, digits, &c.

MEASURE *of Velocity*, in Mechanics, is the space passed over by a moving body in a given time. To measure a velocity therefore, the space must be divided into as many equal parts as the time is conceived to be divided into; the quantity of space answering to such a part of time is the measure of the velocity.

MEASURE *of Force for perforating Metal and other Substances.* The measure of the force necessary to punch a hole through a plate of metal or other substance, must be an interesting subject to scientific readers. We shall therefore here insert the result of some of Mr. Bevan's experiments made on that subject. A good cylindrical steel punch was made, and fitted to a guide or director, so as to move correctly to a cylindrical hole in a steel plate connected with the guide; with this instrument the artist was able to force cylinders of metal very uniform, and with little or no bur to the hole, both by simple pressure and by percussion. The results of some experiments made on the force of simple pressure, to make a hole through a metal plate of one-eighth of an inch in thickness, and one-fourth of an inch in diameter, are as follow:—Plate iron, 3900 lbs.; cast brass, 3200 lbs.; hammered brass, 3600 lbs.; copper, 2800 lbs. The following are the results from the same machine, on specimens of wood, in the direction of the grain, of the same thickness and diameter:—Christiania deal, 135 lbs.; mahogany, 170 lbs.; dry box wood, 356 lbs.; beech, 204 lbs.; ash, 197lbs.; oak 156 lbs.: elm, 122 lbs.

MEASURE, in a legal and commercial sense, denotes a certain quantity or proportion of any thing bought, sold, valued, or the like. On the 1st of May, 1825, a total alteration took place in the weights and measures hitherto used in Great Britain.

*The Rationale of the Imperial System*—Take a pendulum which will vibrate seconds in London, on a level of the sea, in a vacuum; divide all that part thereof which lies between the axis of suspension and the centre of oscillation into 391393 equal parts; then will ten thousand of those parts be an imperial inch, twelve whereof make a foot, and thirty-six whereof make a yard.

*The Standard Yard* is, "that distance between the centres of the two points in the gold studs in the straight brass rod, now in the custody of the clerk of the House of Commons, whereon the words and figures 'Standard Yard, 1760,' are engraved, which is declared to be the genuine standard of the measure of length called a yard: and as the expansibility of the metal would cause some variation in the length of the rod in different degrees of temperature, the act determines that the brass rod in question shall be of the temperature of 62 deg. Faht. The measure is to be denominated the "Imperial Standard Yard,' and to be *the only standard whereby all other measures of lineal extension shall be computed.* Thus the *foot*, the *inch*, the *pole*, the *furlong*, and the *mile*, shall bear the same proportion to the imperial Standard Yard as they have hitherto borne to the yard measure in general use."

The act also makes provision for the restoration of the standard yard, in case of loss, destruction, or defacement, by a reference to an *invariable* natural standard, which is to be that proportion which the yard bears to the length of a pendulum, vibrating seconds of time in the latitude of London, in a vacuum at the level of the sea; which is found to be as 36 inches (the yard) to 39·1393 (the pendulum); thus a sure means is established to supply the loss which might by possibility occur.

Take a cube of one such inch of distilled water, at 62° of temperature, by Fahrenheit's thermometer, let this be weighed by any weight, and let such weight be divided into 252458 equal parts, then will one thousand of such parts be a troy grain; and seven thousand of those grains will be a pound avoirdupois, the operation having been performed in air. Ten pounds such as those mentioned, of distilled water, at 62° of temperature, will be a gallon, which gallon will contain two hundred and seventy-seven cubic inches, and two hundred and seventy-four one thousandth parts of another cubic inch.

*The Standard Pound*, is determined to be that standard pound *troy* weight made in the year 1758, in the custody of the clerk of the House of Commons; such weight is to be denominated the "Imperial Standard Troy Pound;" and after the first of May, 1825, it is to be "*the only standard measure of weight from which all other weights shall be derived, computed, and ascertained* and that one twelfth part of the said troy pound shall be *an ounce*, and one twentieth part of such ounce shall be *a pennyweight*, and that one twenty-fourth part of such penny weight shall be *a grain*; so that 5760 such grains shall be *a pound troy*, and 7000 such grains shall be declared to be *a pound avoirdupois*, and one sixteenth part of the said pound avoirdupois shall be *an ounce avoirdupois*, and one sixteenth part of such ounce shall be *a drachm*."

If the standard pound shall be lost, destroyed, or defaced, the act directs that it shall be recovered by reference to the weight of a cubic inch of water: it having been ascertained that a cubic inch of distilled water, weighed in air by brass weights at the temperature of 62 deg. Fah. and the barometer at 30 inches, is equal to 252·458 grains, and as the standard troy pound contains 5760 such grains, it is therefore established that the original standard pound may be at any time recovered by making another weight to bear the proportion just mentioned to a cubic inch of water.

*The Standard Gallon* is determined by the act to be such measure as shall contain ten pounds avoirdupois of distilled water, weighed in air, at the temperature of 62 deg. Fah. and the barometer at 30 inches, and such measure is declared to be the "Imperial Standard Gallon, and shall be the unit and *only standard measure of capacity to be used, as well for wine, beer, ale, spirits, and all sorts of liquids, as for dry goods not measured by heaped measure*; and that all other measures shall be taken in parts or multiples of the said imperial standard gallon—the quart being the fourth part of such gallon, and *the pint* one-eighth part—two such gallons making a *peck*, eight such gallons *a bushel*, and eight such bushels *a quarter* of corn, or other dry goods, not measured by heaped measure.

*The standard for heaped Measure*, for such things as are commonly sold by heaped measure, such as coal, culm, lime, fish, potatoes, fruit, &c. shall be "*the aforesaid bushel*, containing eighty pounds avoirdupois of water, as aforesaid, the same being made round with a plane and even bottom, and being 19½ inches from outside to outside;" and goods thus sold by heaped measure, shall be heaped "in the form of a cone, such cone to be of the height of at least six inches, the outside of the bushel to be the extremity of the base of such cone;" three such bushels shall be a *sack*, and twelve such sacks shall be a *chaldron*.

*Stricken Measure.* The last mentioned goods may be sold either by the heaped measure, or by the standard weight as before mentioned; but all other kind of goods not usually sold by heaped measure, which may be sold or agreed for by measure, the same standard measure shall be used, but it shall not be heaped, but stricken with a round stick, or roller, straight, and of the same diameter from end to end.

N. B. Copies and models of the standard of length, weight, and measure, are to be made and verified under the direction of the Treasury, and every county to be supplied with them for reference whenever required; and after the first of May, 1825, all contracts for sale, &c. by weight or measure shall relate to the standard, unless the contrary is specified. Existing weights and measures may be used, being marked so as to shew the proportion they have to the standard measures and weights. Tables of equalization of the weights to be made by the Treasury. Tables also for the customs and excise, by which the duties will be altered so as to make them equal to what they are at present, in consequence of the alterations in the weights and measures. *See* WEIGHTS, &c.

The following extracts from the bill for ascertaining and establishing Uniformity of Weights and Measures, will explain this subject fully:—"Whereas it is necessary, for the security of commerce, and for the good of the community, that weights and measures should be just and uniform: and whereas, notwithstanding it is provided by the Great Charter, that there shall be but one measure and one weight throughout the realm, and, by the treaty of union between England and Scotland, that the same weights and measures should be used throughout Great Britain as were then established in England, yet different weights and measures, some larger and some less, are still in use in various places throughout the united kingdom of Great Britain and Ireland, and the true measure of the present standard is not verily known, which is the cause of great confusion and of manifest frauds; for the remedy and prevention of those evils for the future, and to the end that certain standards of weights and measures should be established throughout the united kingdom of Great Britain and Ireland:

"Be it therefore enacted by the king's most excellent majesty, by and with the consent of the lords spiritual and temporal, and Commons, in this present parliament assembled, and by the authority of the same, That a cubic inch of distilled water in a vacuum weighed by brass weights, also in a vacuum at the temperature of sixty-two degrees of Fahrenheit's thermometer, is equal to two hundred and fifty-two grains and seven hundred and twenty-four thousandth parts of a grain.

"And be it further enacted, That the standard measure of capacity, as well for liquid as for dry goods not measured by heaped measure, shall be the gallon containing ten pounds avoirdupois weight of distilled water, weighed in air, at the temperature of sixty-two degrees of Fahrenheit's thermometer, the barometer being at thirty inches, to be used as well for wine, beer, ale, spirits, and all sorts of liquids, as for dry goods not measured by heap measure; and eight such gallons shall be a bushel, and eight such bushels, a quarter of corn or other dry goods not measured by heaped measure.

"And be it further enacted, That the standard measure of capacity, for coals, culm, lime, fish, potatoes, or fruit, and all other goods and things commonly sold by heaped measure, shall be the aforesaid bushel, containing eighty pounds avoirdupois of water as aforesaid, the same being made round with a plane and even bottom, and being nineteen inches and a half from outside to outside of such standard measure as aforesaid.

"And be it further enacted, That all contracts, bargains, sales, and dealings, which shall be made or had within any part of the united kingdom of Great Britain and Ireland, for any work to be done, or for any goods, wares, merchandise, or other thing to be sold, delivered, done, or agreed for, by weight or measure, where no special agreement shall be made to the contrary, shall be deemed, taken, and construed to be made and had according to the weights and standard measures ascertained by this act; and in all cases where any special agreement shall be made, with reference to any weight or measure established by local custom, the ratio or proportion which every such local weight or measure shall bear to any of the said standard weights or measures, shall be expressly declared and specified in such agreement, or otherwise such agreement shall be null and void.

"And whereas it is expedient that persons should be allowed to use the several weights and measures which they may have in their possession, although such weights and measures may not be in conformity with the standard weights and measures established by this act; be it therefore enacted, That it shall and may be lawful for any person or persons to buy and sell goods and merchandise by any weights or measures established either by local custom, or founded on special agreement; provided always, that in order that the ratio or proportion which all such measures and weights shall bear to the standard weights and measures established by this act, shall be and become a matter of common notoriety, the ratio or proportion which all such customary measures and weights shall bear to the said standard weights and measures, shall be painted or marked upon all such customary weights and measures respectively; and that nothing herein contained shall extend, or be construed to extend, to permit any maker of weights or measures, or any person or persons whomsoever, to make any weight or measure at any time after, except in conformity with the standard weights and measures established under the provisions of this act.

"And be it further enacted, That accurate tables shall be prepared and published, shewing the proportions between the weights and measures heretofore in use, as mentioned in such inquisitions, and the weights and measures hereby established; and after the publication of such tables, all future payments to be made shall be regulated according to such tables.

"And whereas the weights and measures by which the rates and duties of the customs and excise, and other his majesty's revenue, have been heretofore collected, are different from the weights and measures of the same denominations directed by this act to be universally used; and whereas the alteration of such weights and measures may, without due care had therein, greatly affect his majesty's revenue, and tend to the diminishing of the same; for the prevention thereof, be it therefore enacted, That, so soon as conveniently may be, accurate tables shall be prepared and published; in order that the several rates and duties of customs and excise, and other his majesty's revenue, may be adjusted and made payable according to the respective quantities of the legal standards directed by this act to be universally used; and that from and after the publication of such tables, the several rates and duties thereafter to be collected by any of the officers of his majesty's customs or excise, or other his majesty's revenue, shall be collected and taken according to the calculations in the tables to be prepared as aforesaid."

TABLE *of the several Standard Measures.*—ENGLISH.

Barleycorns *Long Measure.*

3 = 1 Inch
36 = 12 = 1 Foot
108 = 36 = 3 = 1 Yard
594 = 198 = 16½ = 5½ = 1 Pole
23760 = 7920 = 660 = 220 = 40 = 1 Furlong
190080 = 63360 = 5280 = 1760 = 320 = 8 = 1 Mile

Also,

4 Inches............ = 1 Hand
6 Feet ............ = 1 Fathom.
3 Miles ............ = 1 League.
60 Geographical Miles = 1 Degree.
69⅓ English Miles = 1 Degree nearly.
360 Degrees, or 25000 Miles, is equal to the Circumference of the Earth nearly.

*Cloth Measure.*

Inches
2½ = 1 Nail
9 = 4 = 1 Quarter.
36 = 16 = 4 = 1 Yard.
27 = 12 = 3 = 1 Ell Flemish.
45 = 20 = 5 = 1 Ell English.
54 = 24 = 6 = 1 Ell French.

The French standard was formerly the aune or ell, containing 3 Paris feet, 7 inches, 3 lines, or 1 yard 2-sevenths English; the Paris foot royal exceeding the English by 68-thousandth parts. This ell is divided two ways, *viz.* into halves, thirds, sixths, and twelfths; and into quarters, half-quarters, and sixteenths.

The standard in Holland, Flanders, Sweden, a good part of Germany, many of which were formerly called the Hanstowns, as Dantzic and Hamburgh, and at Geneva, Frankfort, &c. is likewise the ell; but the ell in all these places differs from the Paris ell. In Holland it contains one Paris foot eleven lines, or four-sevenths of the Paris ell. The Flanders ell contains two feet, one inch, five lines, and half a line, or seven-twelfths of the Paris ell. The ell of Germany, Brabant, &c. is equal to that of Flanders.

The Italian measure is the branchio, brace, or fathom. This obtains in the states of Modena, Venice, Florence, Lucca, Milan, Mantua, Bologna, &c. but is of different lengths. At Venice it contains one Paris foot eleven inches three lines, or eight-fifteenths of the Paris ell. At Bologna, Modena, and Mantua, the brace is the same as at Venice. At Lucca it contains one Paris foot nine inches ten lines, or half a Paris ell. At Florence, it contains one foot nine inches four lines, or forty-nine hundredths of a Paris ell. At Milan, the brace for measuring of silks is one Paris foot seven inches four lines, or four-ninths of a Paris ell: that for woollen cloths is the same with the ell of Holland. Lastly, at Bergama, the brace is one foot seven inches six lines, or five-ninths of a Paris ell. The usual measure at Naples, however, is the canna, containing six feet ten inches and two lines, or one Paris ell and fifteen-seventeenths.

The Spanish measure is the vara or yard, in some places called the bara, containing seventeen twenty-fourths of the Paris ell. But the measure in Castile and Valencia is the pan, span, or palm; which is used, together with the canna, at Genoa. In Arragon, the vara is equal to a Paris ell and a half, or five feet five inches six lines.

The Portuguese measure is the cavedos, containing two feet eleven lines, or four-sevenths of a Paris ell; and the vara, an hundred and six whereof make an hundred Paris ells.

The Piedmontese measure is the ras, containing one Paris foot nine inches ten lines, or half a Paris ell. In Sicily, their measure is the canna, the same with that of Naples.

The Muscovy measures are the cubit, equal to one Paris foot four inches two lines; and the arcin, two whereof are equal to three cubits.

The Turkish and Levant measures are the picq, containing two feet two inches and two lines, or three-fifths of the Paris ell. The Chinese measure, the cobre, ten whereof are equal to three Paris ells. In Persia, and some parts of the Indies, the gueze, whereof there are two kinds; the royal gueze, called also the *gueze monkelser*, containing two Paris feet ten inches eleven lines, or four-fifths of the Paris ell; and the shorter gueze, called simply *gueze*, only two-thirds of the former. At Goa and Ormuz, the measure is the vara, the same with that of the Portuguese, having been introduced by them. In Pegu, and some other parts of the Indies, the cando or candi, equal to the ell of Venice. At Goa, and other parts, they use a larger cando, equal to seventeen Dutch ells; exceeding that of Babel and Balsora by ⅛ per cent. and the vara by 6¼. In Siam, they use the ken, short of three Paris feet by one inch. The ken contains two soks, the sok two keubs, the keub twelve nious or inches, the niou to be equal to eight grains of rice, *i. e.* to about nine lines. At Camboia, they use the baster; in Japan, the tatam; and the span on some of the coasts of Guinea.

*Square Measure.*

Inches
144 = 1 Foot.
1296 = 9 = 1 Yard.
39204 = 272¼ = 30¼ = 1 Pole.
1568160 = 10890 = 1210 = 40 = 1 Rood.
6272640 = 43560 = 4840 = 160 = 4 = 1 Acre.
Also, 5½ Yards = 1 Pole.
40 Poles = 1 Rood.
4 Roods = 1 Acre.

*Square, Superficial, or Land Measure.*—English square measures are raised from the yard of 36 inches multiplied into itself, and thus producing 1296 square inches in the square yard; the divisions of this are square feet and inches; and the multiples, poles, roods, and acres. Because the length of a pole is 5½ yards, the square of the same contains 30¼ square yards. A square mile contains 640 square acres. In measuring fens and woodlands, 18 feet are generally allowed to the pole, and 21 feet in forest land. A hide of land, frequently mentioned in the earlier part of the English history, contained about 100 arable acres; and five hides were esteemed a knight's fee. At the time of the Norman conquest, there were 243,600 hides in England.

Scotch square or land measure is regulated by the Scotch ell: 36 square ells = 1 fall, 40 falls = 1 rood, 4 roods = acre. The proportion between the Scotch and English acre, supposing the feet in both measures alike, is as 1369 to 1089, or nearly as 5 to 4. If the difference of the feet be regarded, the proportion is as 10,000 to 7869. The length of the chain for measuring land in Scotland is 23 ells, or 74 feet. A husband-land contains six acres of sock and scythe land, that is, of land that may be tilled with a plough or mown with a scythe; 13 acres of arable land make one ox-gang; and four ox-gangs make a poundland of old extent.

French square measures are regulated by 12 square lines in the inch square, 12 inches in the foot, 22 feet in the perch, and 100 perches in the arpent or acre.

*Cubic Measure.*

Inches.
1728 = 1 Foot.
46656 = 27 = 1 Yard.

*Wine Measure*

Pints.
2 = 1 Quart.
8 = 4 = 1 = 1 Gallon = 231 Cubic Inches.
336 = 168 = 42 = 1 Tierce.
504 = 252 = 63 = 1½ = 1 Hogshead.
672 = 336 = 84 = 2 = 1⅓ = 1 Puncheon.
1008 = 504 = 126 = 3 = 2 = 1½ = 1 Pipe.
2016 = 1008 = 252 = 6 = 4 = 3 = 2 = 1 Tun
231 Cubic Inches = 1 Gallon.
10 Gallons = 1 Anker.
18 Ankers = 1 Runlet.
31½ Gallons = 1 Barrel.

*Ale and Beer Measure.*

Pints.
2 = 1 Quart.
8 = 4 = 1 Gallon.
72 = 36 = 9 = 1 Firkin.
144 = 72 = 18 = 2 = 1 Barrel.
288 = 144 = 36 = 4 = 2 = 1 Barrel.
432 = 216 = 54 = 6 = 3 = 1½ = 1 Hogshead.
576 = 288 = 72 = 8 = 4 = 2 = 1⅓ = 1 Puncheon.
864 = 432 = 108 = 12 = 6 = 3 = 2 = 1½ = 1 Butt.

The Ale Gallon contains 282 Cubic Inches.

SCOTCH.—*Long Measure.*

| | | Eng. Inches. |
|---|---|---|
| An Ell ................ | = | 37·2 |
| A Fall ................ | = | 223·2 |
| A Furlong ............ | = | 8928 |
| A Mile ................ | = | 71424 |
| A Link ................ | = | 8·928 |
| A Chain, or Short Rood | = | 89·28 |
| A Long Rood | = | 1339·2 |

*Measure of Capacity.*

| | | Eng. Cub. Inch. |
|---|---|---|
| A Gill | = | 6·462 |
| A Mutchkin | = | 25·85 |
| A Choppin | = | 51·7 |
| A Pint | = | 103·4 |
| A Quart | = | 206·8 |
| A Gallon | = | 827·23 |
| A Hogshead | = | 13235·7, or 16 Gallons. |

*Cubical Measures, or Measures of Capacity, for Liquids.*—The English measures were originally raised from troy weight: it being enacted by several statutes, that eight pounds troy of wheat, gathered from the middle of the ear, and well dried, should weigh a gallon of wine measure, the divisions and multiples whereof were to form the other measures; at the same time it was also ordered, that there should be but one liquid measure in the kingdom; yet custom has prevailed, and there having been introduced a new weight, *viz.* the avoirdupois, we have now a second standard gallon adjusted thereto, and therefore exceeding the former in the proportion of the avoirdupois weight to troy weight. From this latter standard are raised two several measures, the one for ale, the other for beer The sealed gallon at Guildhall, which is the standard for wines, spirits, oils, &c. was supposed to contain 231 cubic inches; and on this supposition the other measures raised therefrom will contain as in the foregoing table; yet by actual experiment, made in 1688, before the lord mayor and the commissioners of excise, this gallon was found to contain only 224 cubic inches; it was, however, agreed to continue the common supposed contents of 231 cubic inches; so that all computations stood on their own footing. Hence, as 12 is to 231, so is $14\frac{13}{20}$ to 281½, the cubic inches in the ale gallon; but in effect the ale quart contained 70½ cubic inches, on which principle the ale and beer gallon will be 282 cubic inches. The several divisions and multiples of these measures, and their proportions, are exhibited in the foregoing tables. The barrel for ale in London is 32 gallons, and the barrel for beer 36 gallons. In all other places of England, the barrel, both for ale and beer, was wont to be 34 gallons.

Scotch liquid measure is founded on the pint. The Scotch pint was formerly regulated by a standard jug of cast metal, the custody of which was committed to the borough of Stirling. This jug was supposed to contain 105 cubic inches; and though, after several careful trials, it has been found to contain only about 103½ inches; yet, in compliance with established custom, founded on that opinion, the pint stoups are still regulated to contain 105 inches, and the customary ale measures are about $\frac{1}{16}$ above that standard. It was enacted by James I. of Scotland, that the pint should contain 41 ounces trone weight of the clear water of Tay, and by James VI. that it should contain 55 Scots troy ounces of the clear water of Leith. This affords another method of regulating the pint, and also ascertaining the ancient standard of the trone weight. As the water of Tay and Leith is alike, the trone weight must have been to the Scots troy weight as 55 to 41, and therefore the pound trone must have contained about 21½ ounces Scots troy.

4 gills — 1 mutchkin.
2 mutchkins = 1 chopin.
2 chopins = 1 pint.
2 pints = 1 quart.
4 quarts = 1 gallon.

The Scotch quart contains 210 inches, and is therefore about $\frac{7}{10}$ less than the English wine gallon, and about ¼ less than the ale gallon.

As to the liquid measures of foreign nations, it is to be observed, that their several vessels for wine, vinegar, &c. have also various denominations, according to their different sizes and the places wherein they are used. The woeders of Germany, for holding Rhenish and Moselle wines, are different in their gauges; some containing 14 aumes of Amsterdam measure, and others more or less. The aume is reckoned at Amsterdam for 8 steckans, or 20 verges, or for ⅙ of a tun of 2 pipes, or 4 barrels, of French or Bourdeaux, which ⅙ at this latter place is called *tierçon*, because three of them make a pipe or two barrels, and six the said tun. The steckan is 16 mingles, or 32 pints; and the verge is, in respect of the said Rhenish and Moselle, and some other sorts of wine, 6 mingles; but in measuring brandy it consists of 6⅙ mingles. The aume is divided into 4 anckers, and the ancker into 2 steckans, or 32 mingles. The ancker is taken sometimes for 1/24 of a tun, or 4 barrels; on which footing the Bourdeaux barrel ought to contain at Amsterdam (when the cask is made according to the just gauge) 12½ steckans, or 200 mingles, wine and lees; or 12 steckans, or 192 mingles, racked wine; so that the Bourdeaux tun of wine contains 50 steckans, or 800 mingles, wine and lees; and 48 steckans, or 768 mingles, of pure wine. The barrels or poinçons of Nantes, and other places on the river Loire, contain only 12 steckans, Amsterdam measure. The wine tun of Rochelle, Cogniac, Charente, and the isle of Rhé, differs very little from the tun of Bourdeaux, and consequently from the barrels and pipes. A tun of wine of Chalosse, Bayonne, and the neighbouring places, is reckoned 60 steckans, and the barrel 15, Amsterdam measure.

The old muid of Paris contains 150 quarts or 300 pints, wine and lees; or 280 pints clear wine; of which muids three make a tun.

The butts or pipes from Cadiz, Malaga, Alicant, Benecarlo, Saloe, and Mataro, and from the Canaries, Lisbon, Oporto, and Fayal, are very different in their gauges, though in affreightments they are all reckoned two to the tun.

Vinegar is measured in the same manner as wine, but the measures for brandies are different; these spirits from France Spain, Portugal, &c. are generally shipped in large casks called pipes, butts, and pieces, according to the places from whence they are imported, &c. In France, brandy is shipped in casks called pieces at Bourdeaux, and pipes at Rochelle Cogniac, the isle of Rhé, and other neighbouring places, which contain some more and some less, even from 60 to 90 Amsterdam verges or veertels, according to the capacity of the vessels, and the places they come from.

### *Dry Measure.*

Pints.
8 = 1 Gallon.
16 = 2 = 1 Peck.
64 = 8 = 4 = 1 Bushel.
256 = 32 = 16 = 4 = 1 Coomb.
512 = 64 = 32 = 8 = 2 = 1 Quarter.
2560 = 320 = 160 = 40 = 10 = 5 = 1 Wey.
5120 = 640 = 320 = 80 = 20 = 10 = 2 = 1 Last.
268⅘ Cubic Inches = 1 Gallon.
36 Bushels = 1 Chaldron of Coals.

*Measure of Capacity for things Dry*, was the Winchester gallon heretofore; as for corn, salt, coals, and other dry goods, in England. The gallon contains 272¼ cubic inches. The bushel 8 gallons, or 2178 inches. A cylindrical vessel, 18½ inch. diameter, and 8 inch. deep, is appointed to be used as a bushel in levying the malt tax. A vessel of these dimensions is rather less than the Winchester bushel of 8 gallons, for it contains only 2150 inches, though probably there was no difference intended. The denominations of dry measure commonly used, are given in the first of the subjoined tables. Four quarters of corn make a chaldron, five quarters make a wey or load, and 10 quarters make a ton. In measuring sea coal, five pecks make a bushel, nine bushels make a quarter or vatt, four quarters make a chaldron, and 21 chaldrons make a score.

40 feet hewn timber make a load.
50 feet unhewn timber make a load.
32 gallons make a herring barrel.
42 gallons make a salmon barrel.
1 cwt. gunpowder makes a barrel.
256 lbs. soap make a barrel.
10 dozen candles make a barrel.
12 barrels make a last.

Scotch dry measure. There was formerly only one measure of capacity in Scotland; and some commodities were heaped, others straiked, or measured exactly to the capacity of the standard. The method of heaping was afterwards forbidden as unequal, and a larger measure appointed for such commodities as that custom had been extended to. The wheat firlot, used also for rye, pease, beans, salt, and grass seeds, contains 21 pints 1 mutchkin, measured by the Stirling jug. The barley firlot, used also for oats, fruit, and potatoes, contains 31 pints. A different method of regulating the firlot was appointed from the dimensions of a cylindrical vessel. The diameter for both measures was fixed at 19⅙ inches, the depth 7⅓ inches for the wheat firlot, and 13½ for the barley firlot. A standard constructed by these measures is rather less than when regulated by the pint; and as it is difficult to make vessels exactly cylindrical, the regulation by the pint has prevailed, and the other method gone into disuse.

If the Stirling jug contains 103½ inches, the wheat firlot will contain 2109 inches, which is more than two per cent. larger than the legal malt bushel of England, and about one per cent. larger than the Winchester bushel; and the barley firlot will contain 3208 inches. The barley boll is nearly equal to six legal malt bushels. In Stirlingshire, 17 pecks are reckoned to the boll; in Inverness-shire, 18 pecks; in Ayrshire, the boll is the same as the English quarter. And the firlots in many places are larger than the Linlithgow standard.

French dry, are, the litron, bushel, minot, mine, septier, muid, and tun. The litron is divided into two demilitrons, and four quarter litrons, and contains 36 cubic inches of Paris. By ordonnance, the litron is to be three inches and a half high, and three inches 10 lines broad. The litron for salt is larger, and is divided into two halves, four quarters, eight demi-quarters, and 16 mesurettes. The French bushel is different in different jurisdictions. At Paris it is divided into demi-bushels, each demibushel into two quarts, the quart into two half-quarts, and the half-quart into two litrons, so that the bushel contains 16 litrons. By ordonnance the Paris bushel is to be eight inches two lines and a half high, and ten inches broad, or in diameter within-side. The minot consists of three bushels, the mine of two minots or six bushels, the septier of two mines or 12 bushels, and the muid of 12 septiers or 144 bushels. The bushel of oats is estimated double that of any other grain; so that there go 24 bushels to make the septier, and 288 to make the muid. It is divided into four picotins, the picotin containing two quarts, or four litrons. The bushel for salt is divided into two half bushels, four quarters, eight half-quarters, and 16 litrons; four bushels make a minot, 16 a septier, and 192 a muid. The bushel for wood is divided into halves, quarters, and half quarters. Eight bushels make the minot, 16 a mine; 20 mines, or 320 bushels, the muid. For plaster, 12 bushels make a sack, and 36 sacks a muid. For lime, three bushels make a minot, and 48 minots a muid. The minot is by ordonnance to be 11 inches 9 lines high, and 14 inches 8 lines in diameter. The minot is composed of three bushels, or 16 litrons; four minots make a septier, and 48 a muid. The French mine is no real vessel, but an estimation of several others. At Paris the mine contains six bushels, and 24 make the muid; at Rouen the mine is four bushels; and at Dieppe 18 mines makes a Paris muid. The septier differs in different places: at Paris it contains two mines, or eight bushels, and 12 septiers the muid. At Rouen the septier contains two mines or 12 bushels. Twelve septiers make a muid at Rouen as well as at Paris; but 12 of the latter are equal to 14 of the former. At Toulon the septier contains a mine and a half; three of which mines make the septier of Paris. The muid or muy of Paris consists of 12 septiers, and is divided into mines, minots, bushels, &c. That for oats is double that for other grain, *i. e.* contains twice the number of bushels. At Orleans the muid is divided into mines, but those mines only contain two Paris septiers and a half. In some places they use the tun in lieu of the muid, particularly at Nantes, where it contains 10 septiers of 16 bushels each, and weighs between 2200 and 2250 pounds. Three of these tuns make 28 Paris septiers. At Rochelle, &c. the tun contains 42 bushels, and weighs two per cent. less than that of Nantes. At Brest it contains 20 bushels, is equal to 10 Paris septiers, and weighs about 2240 pounds. *See* TUN.

Dutch, Swedish, Polish, Prussian, and Muscovite. In these places, they estimate their dry things on the foot of the *last*, *lest*, *leth*, or *lecht*; so called according to the various pronunciations of the people who use it. In Holland, the last is equal to 19 Paris septiers, or 38 Bourdeaux bushels, and weighs about 4560 pounds; the last they divide into 27 muids, and the muid into four scheples. In Poland, the last is 40 Bourdeaux bushels, and weighs about 4800 Paris pounds. In Prussia, the last is 133 Paris septiers. In Sweden and Muscovy they measure by the great and little last; the first containing 12 barrels, and the second half as many.

In Muscovy, they likewise use the chefford, which is different in various places; that of Archangel is equal to three Rouen bushels.

Italian. At Venice, Leghorn, and Lucca, they estimate their dry things on the foot of the staro or staio; the staro of Leghorn weighs 54 pounds; 112 staros and seven-eighths are equal to the Amsterdam last. At Lucca, 119 staros make the last of Amsterdam. The Venetian staro weighs 128 Paris pounds; the staro is divided into four quarters. Thirty-five staros and one-fifth, or 140 quarters and four-fifths, make the last of Amsterdam. At Naples and other parts, they use the tomolo or tomalo, equal to one-third of the Paris septier. Thirty-six tomoli and a half make the carro, and a carro and a half, or 54 tomoli, make the last of Amsterdam. At Palermo, 16 tomoli make the salma, and four mondili the tomolo. Ten salmas and three-sevenths, or 171 tomoli and three-sevenths, make the last of Amsterdam.

Flemish. At Antwerp, &c. they measure by the viertel; 32 and one-half whereof make 19 Paris septiers. At Hamburgh, the schepel; 90 whereof make 19 Paris septiers.

Spanish and Portuguese. At Cadiz, Bilboa, and St. Sebastian, they use the fanega; 23 whereof made the Nantes or Rochelle tun, or nine Paris septiers and a half; though the Bilboa fanega is somewhat larger, insomuch that 21 fanegas make a Nantes tun. At Seville, &c. they use the anagoras, containing a little more than the Paris mine; 36 anagoras make 19 Paris septiers. At Bayonne, &c. the concha; 30 whereof are equal to nine Paris septiers and a half. At Lisbon, the alquiver, a very small measure, 240 whereof make 19 Paris septiers, 60 the Lisbon muid.

TABLE *of the several Standard Measures.*—FRENCH.

*Old System.*

| | | |
|---|---|---|
| A Point | ·0148025 | English Inches. |
| A Line | ·088815 | ——— |
| An Inch | 1·06578 | ——— |
| A Foot | 12·78933 | ——— |
| An Ell | 44 | French Inches. |
| A Sonde | 5 | French Feet. |
| A Toise — | 6 | ——— |
| A Perch — | 18 | ——— |
| A Perch Royal — | 22 | ——— |
| A League | 2282 | Toises. |
| A Square Inch | 1·13582 | English Inches. |
| An Arpent | ⅚ | English Acre. |
| Arpent Royal | 1¼ | ——— |
| A Cubic Inch | 1·21063 | English Cub. Inch. |
| A Litron | 65·34 | ——— |
| A Boisseau | 16 | Litrons. |
| A Minot | 3 | Boisseaux. |
| A Mine | 2 | Minots. |
| A Septier | 2 | Mines. |
| A Muid | 12 | Septiers. |

*Metre Measure.—Superficial Measure.*

| | Eng. Yards. |
|---|---|
| Are, a Square Decametre | 119·6046 |
| Decare | 1196·046 |
| Hecatare | 11960·46 |

*Lineal Measure.*

| | Eng. Inches. | | Eng. Inches. |
|---|---|---|---|
| Millimetre | 0·3937 | Decametre | 393·71 |
| Centimetre | ·39371 | Hecametre | 3937·1 |
| Decimetre | 3·9371 | Chiliometre | 39371· |
| Metre | 39·371 | Myriometre | 393710· |

*Note.* An English Inch = ·0531 Metres.

*Measure of Capacity.*

| | Eng. Cub. Inc. | | Eng. Cub. Inc. |
|---|---|---|---|
| Millilitre | ·06103 | Decalitre | 610·28 |
| Centilitre | ·61028 | Hecatolitre | 6102·8 |
| Decilitre | 6·1028 | Chiliolitre | 61028 |
| Litre | 61·028 | Myriolitre | 610280· |

*Solid Measure.*

| | Eng. Cub. Feet. |
|---|---|
| Decistre, for fire wood | 3·5317 |
| Stere, a Cubic Metre | 35·317 |
| Decastere | 353·17 |

It will be observed, that, in this system it is only necessary to remember the metre, are, litre, and stere, all the others having certain relations to these, being equal to them taken 10, 100, 1000, &c. times, or divided by those numbers; and these are indicated in all cases by the preceding part of the word, the terminations in all being the same; that is, in each class of measures. Thus,

*Deca* prefixed, denotes 10 times; *heca*, 100 times; *chilio*, 1000 times; &c. On the other hand, *deci*, *centi*, *milli*, denotes the 10th part, 100th part, 1000th part, &c. So that *metre* is the element of long measures; *are*, of superficial measures; *stere*, that of solid measure; and *litre*, is the element of the measures of capacity; also, *gramme* is the element of all weights, being itself the weights of a cubic centimetre of distilled water.—The *are* is the square *decametre*. The *litre*, the cubic *decimetre*. The *stere*, the cubic *metre*. The *metre* itself, one ten-millionth part of the terrestrial arc intercepted between the equator and north pole, as determined by the actual measurement of degrees in different latitudes.

One need only cast an eye over this system of measures, to see at once the great advantages that it posseses over the complicated systems of any other country. It not only renders the system incomparably more simple for all the practical purposes of life, but it annihilates at once all those rules in arithmetic, classed under the terms compound addition, subtraction, multiplication, and division; reducing the whole of arithmetic to the first simple rules. A child, under this system of weights and measures, may learn every thing necessary for entering into the common concerns of the world in a month, as well and better than in a year under our complicated system. It is perhaps too much to expect that we shall ever forego our prejudices so far as to adopt this system of a rival nation. Yet it must be allowed to be of infinite importance to reduce all those incongruous and incomparable measures now in use, to one simple and uniform system, that should be understood by every one; and we should therefore be happy to find the subject taken up by the English parliament, being well worthy of its serious attention.

Table of the Proportion of Long Measures of different Nations to the English Foot; which, for the sake of comparison, is supposed to be divided into 1000 parts.

| | |
|---|---|
| English foot | 1000 |
| Paris | 1068 |
| Venetian | 1162 |
| Rhinland | 1033 |
| Strasburgh | 951 |
| Noremberg | 1000 |
| Dantzic | 944 |
| Danish | 1042 |
| Swedish | 977½ |

*Different Itinerary Measures.*

| | | |
|---|---|---|
| A French league is about | $2\frac{3}{4}$ | English miles. |
| A German mile......... | 4 | Ditto. |
| A Dutch mile .......... | $3\frac{1}{4}$ | Ditto. |
| An Italian mile ........ | $\frac{11}{12}$ | Ditto. |
| A Spanish league....... | $3\frac{2}{3}$ | Ditto. |
| A Russian verst........ | $\frac{3}{4}$ | Ditto. |

*Standard of* MEASURE. Various attempts have been made by different mathematicians to find a perpetual standard of measure, which might be referred to at any time and under any circumstance, supposing the standard in present use to be lost. The above metric system of the French is founded on this principle; the terrestrial arc, from the equator to the pole, being taken as the standard of universal comparison.

MEASURE, in Geometry, denotes any quantity assumed as one or unity, to which the ratio of the other homogeneous or similar quantities is expressed.

MEASURE *of Wood for Firing*, is usually the cord, four feet high, as many broad, and eight long; this is divided into two half cords, called the *ways*, and by the French *membrures* from the pieces stuck upright to bound them; or *voyes*, as being supposed half a waggon load.

MEASURE *for Horses*, is the hand, which by statute contains four inches.

MEAT, THE PRESERVATION. The Moors have an easy method of preparing flesh-meat, without spices, and very little salt, to keep it good, and always ready for eating, for two or three years in the warmest climates. The meat thus prepared is called *elcholle*, and is made of beef, mutton, or camel's flesh, but chiefly of beef. It is first uniformly cut in long slices, well salted, and suffered to lie twenty-four hours in the pickle. It is then removed from those tubs into others filled with fresh water, where it remains for a night; it is next taken out, and hung on cords in the sun to dry. When thoroughly dry and hard, it is cut into pieces three inches long, and thrown into a pan or cauldron of boiling oil and suet sufficient to cover it; thus it is boiled, till it be very clear and red on cutting it, when it is again taken out, and set to drain. After having undergone this process, it stands to cool, while jars are prepared for storing it; at the same time pouring upon it the liquid in which it was boiled or fried; and as soon as it is thoroughly cold, the vessels are closely stopped. Preserved in this manner, it will remain hard, and keep good for two years; the hardest is considered the best and most palatable. Thus it is brought to the table by the Moors, after having been stewed or fried, seasoned either with garlic, or the juice of lemon, and is considered an excellent dish. Meat is also preserved by the pyroligneous acid. *See* ACID.

MECHANICAL, an epithet applied to whatever relates to mechanics: Thus we say, mechanical powers, causes, &c. The mechanical philosophy is the same with what is otherwise called *corpuscular philosophy*, which explains the phenomena of nature, and the operations of corporeal things, on the principles of mechanics; *viz.* the motion, gravity, arrangement, disposition, greatness or smallness, of the parts which compose natural bodies. This manner of reasoning is much used in medicine; and, according to Dr. Quincy, is the result of a thorough acquaintance with the structure of animal bodies: for considering an animal body as a composition out of the same matter from which all other bodies are formed, and to have all those properties which concern a physician's regard, only by virtue of its peculiar construction; it naturally leads a person to consider the several parts, according to their figure, contexture, and use, either as wheels, pulleys, wedges, levers, screws, cords, canals, strainers, &c. For which purpose, continues he, it is frequently found helpful to design in diagrams, whatsoever of that kind is under consideration, as is customary in geometrical demonstrations.

MECHANICAL, in Mathematics, denotes a construction of some problem, by the assistance of instruments, as the duplicature of the cube and quadrature of the circle, in contradistinction to that which is done in an accurate and geometrical manner.

MECHANICAL *Curve*, is a curve, according to Descartes, which cannot be defined by any algebraic equation; and so stands contradistinguished from algebraic or geometrical curves. Leibnitz and others call these mechanical curves *transcendental*, and dissent from Descartes, in excluding them out of geometry. Leibnitz found a new kind of transcendental equations, where these curves are defined: but they do not continue constantly the same in all points of the curve, as algebraic ones do. *See* TRANSCENDENTAL.

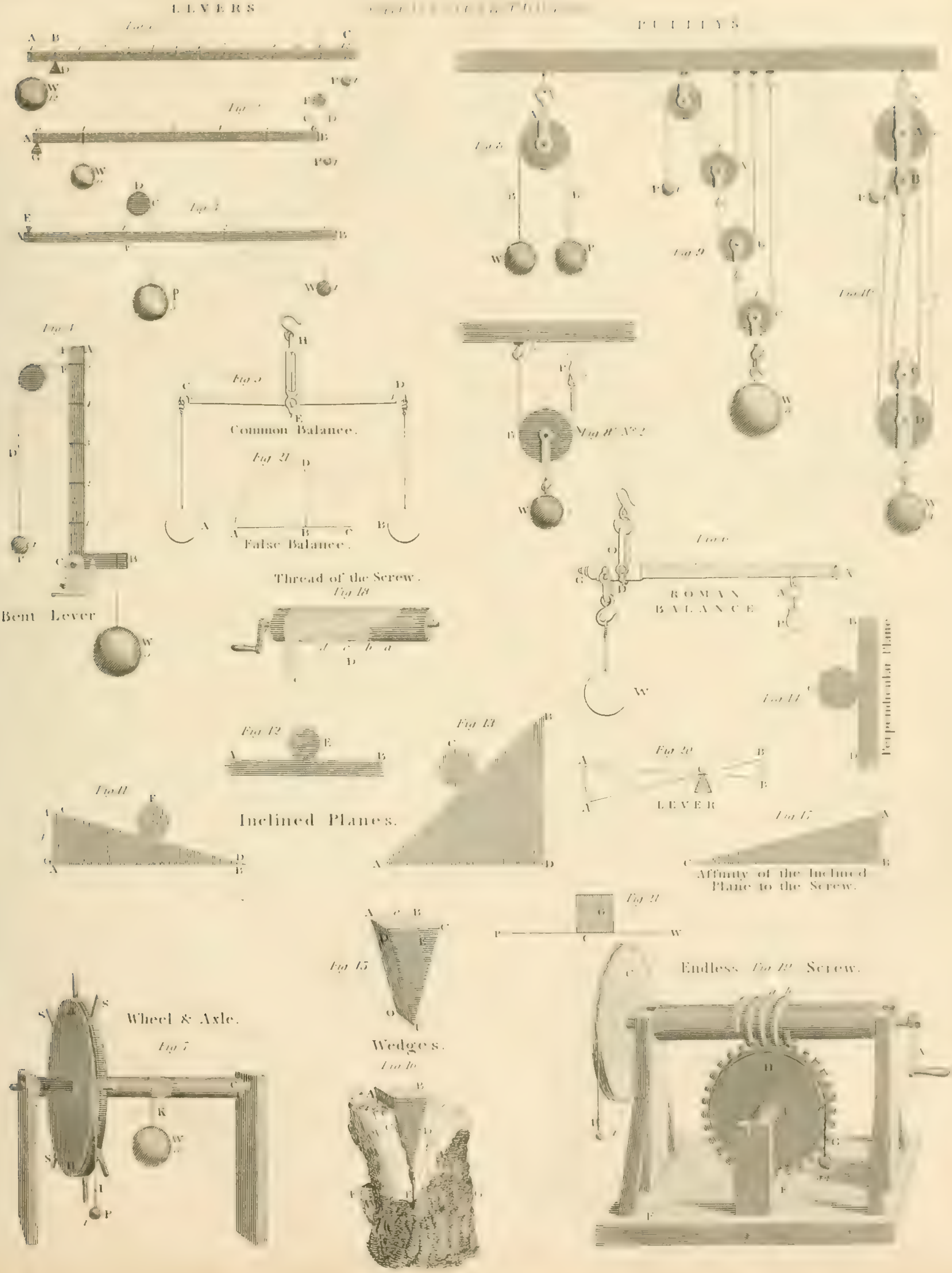
MECHANICAL *Solution of a Problem*, is either when the thing is done by repeated trials, or when lines used in the solution are not only truly geometrical, or by organical construction.

MECHANICS, that branch of practical mathematics, which considers motion and moving powers, their nature and laws, with their effect in machines. *See* MACHINE. The term is equally applied to the doctrine of equilibrium of powers, more properly called statics, and to that science which treats of the generation and communication of motions, which constitutes dynamics, or mechanics strictly so called. This science is divided by Newton into practical and rational mechanics, the former of which relates to the mechanical powers; *viz.* the lever, balance, wheel and axis, pulley, wedge, screw, inclined plane, and funicular machine: and the latter, or rational mechanics, to the theory of motion; shewing when the forces or powers are given, how to determine the motion that will result from them; and conversely, when the circumstances of the motion are given, how to trace the forces or powers from which they arise. Leslie, in his course of natural philosophy, incorporates mechanics with those other branches of natural science which unfold the general principles that connect the events of the material world. The science of mechanics having thence for its object the consideration of machines, their elements, principles of action, and methods of operation, we may divide them into two classes—those that are general, and such as are particular: To the former belong the concentrator of force, and the engine of oblique action, which, when composed of connected cords, has been named the *funicular machine*;—to the latter belong the lever, the wheel and axle, the inclined plane and screw, the wedge, and the pulley, commonly called the simple mechanical powers.

Mechanics, according to the ancient sense of the word, considers only the energy of *organa*, or machines. The authors who have treated the subject of mechanics systematically, have observed, that all machines derive their efficacy from a few simple forms and dispositions that may be given to the *organa*, which are interposed between the agent and the resistance to be overcome; and to those simple forms they have given the name of mechanical powers, simple powers, or simple machines. The practical uses of the several mechanical powers were undoubtedly known to the ancients, but they were almost wholly unacquainted with the theoretical principles of this science till a very late period; and it is, therefore, not a little surprising that the construction of machines, or the instruments of mechanics, should have been pursued with such industry, and carried by them to such perfection. Vitruvius, in his tenth book, enumerates several ingenious machines, which had then been in use from time immemoral. We find, that for raising or transporting heavy bodies, they employed most of the means which are at present commonly used for that purpose, such as the crane, the inclined plane, the pulley, &c.; but with the theory or true principles of equilibrium they seem to have been unacquainted till the time of Archimedes. When, however, we consider the vast gigantic undertakings of the ancients, we cannot help believing that their genius supplied them with many engines of which we now know nothing; though we far surpass them in numerous methods of abridging human labour and the application of force. Yet from the time of Archimedes till the sixteenth century, the theory of mechanics remained as that prince of science left it. Stevenus a Fleming, Galileo, Torricelli, Descartes, Huygens, Wallis, Wren, Newton, Leibnitz, Dechales, Oughtred, Keil, Delahire, Lagrange, Atwood, Prony, Emerson, Watt, Gregory, Young, &c. have, in succession, since the period to which we have alluded, explained and applied the principles of this civilizing science in a wonderful manner.

*The Lever*, which consists of an inflexible bar A B C, (see the Plate, fig. 20,) either straight or bent, resting on a point C, called the *fulcrum*, the *power* being applied at the end A of

Plate I.


LEVERS
PULLYS
A B C D W P
A C D B G W P
D C E F B W P
Fig. 4
Common Balance.
Fig. 21
False Balance.
Thread of the Screw.
Fig. 18
Bent Lever
Fig. 8
Fig. 9
Fig. 10
Fig. 8 No. 2
ROMAN BALANCE
Perpendicular Plane
Fig. 12
Fig. 13
Fig. 20
LEVER
Fig. 11
Inclined Planes.
Fig. 17
Affinity of the Inclined Plane to the Screw.
Fig. 15
Wedges.
Fig. 16
Wheel & Axle.
Fig. 7
Endless Fig. 19 Screw.

the arm A C, to raise a *weight* at the end B of the other arm C B. Throwing out of view the weight of the lever itself, and supposing it to be at first horizontal; let it shift into the proximate position $A'CB'$. The minute arcs $AA'$ and $BB'$ thus described may be regarded as tangents, and, consequently, while the power P descends vertically through the space $AA'$, the weight W rises through the space $BB'$; wherefore the opposite momenta being equal, $P \times AA' = W \times BB'$, and $P : W :: BB' : AA' :: BC : AC$, or the power and weight are inversely as their distance from the fulcrum. Levers are usually distinguished into three kinds, according to the relative position of the power, the weight, and the fulcrum. 1. When the fulcrum D, (fig. 1,) lies between the power P and the weight W. This kind includes the crow and handspike, pincers, and scissars. The toothed hammer is only a bent lever of this kind. Its invention was in mythology ascribed to Neptune, his *trident* being only a three-pronged crow. The arm B C is commonly longer than A B, and consequently the weight W exceeds the power P. The number of times which the weight contains the power, is always called the *mechanical advantage* or *purchase*.

In making experiments with this machine, the shorter arm A B must be as much thicker than the longer arm B C as will be sufficient to balance it on the prop D. This supposed, let P represent a power whose weight or purchase is equal to 1 pound, and let the weight of W equal 12 pounds, then, if the power be twelve times as far from the fulcrum as the weight is, they will exactly counterpoise; and a small addition of purchase to the power P will force it down, and raise the weight W; and the velocity with which the power descends will be to the velocity with which the weight rises, as 12 to 1; that is, directly as their distances from the fulcrum, and, consequently, as the spaces through which they move. Hence, a man, who, by his natural strength, without the help of any machine, could support a hundred weight, will by the help of this lever be enabled to support twelve hundred. If the weight be less, or the power greater, the fulcrum may be placed so much farther from the weight; and then it can be raised to a proportionably greater height. For, universally, if the intensity of the weight multiplied into its distance from the fulcrum, be equal to the intensity of the power multiplied into its distance from the fulcrum, the power and weight will exactly balance each other; and a little addition to the power will raise the weight. Thus, in the present instance, the weight W is 12 pounds, and its distance from the fulcrum 1 inch; and 12 multiplied by 1 is 12; the power P is equal to 1 pound, and its distance from the prop is 12 inches, which multiplied by 1 is 12 again; and therefore there is an equilibrium between them. So, if a power equal to 2 pounds be applied at the distance of 6 inches from the fulcrum, it will just balance the weight W; for $6 \times 2 = 12$, as before; and a power equal to 3 pounds placed at 4 inches' distance, would be the same; for $3 \times 4 = 12$; and so on in proportion.

The statera, or Roman steelyard, explained under the word BALANCE, and used for finding the weights of different bodies by one single weight placed at different distances from the fulcrum or centre of motion D, (fig. 6,) is a lever of this kind. For, if a weight be hung at A, the extremity of the shorter arm D G is of such a weight as exactly to counterpoise the longer arm D X; if this arm be divided into any number of equal parts, each equal to O D, the single weight P will serve for weighing any thing as heavy as itself, or as many times heavier as there are divisions in the arm D X, or any quantity between its own weight and that quantity. As for example: If $P = 1$ pound, be placed at the first division 1 in the arm D X, it will balance 1 pound in the scale at W; if it be removed to the second division at 2, it will balance 2 pounds in the scale W; if to the third, 3 pounds; and so on to the end of the arm D X. If each of these integral divisions be subdivided into as many equal parts as a pound contains ounces, and the weight P be placed at any of these subdivisions, so as to counterpoise what is in the scale, the pounds and odd ounces therein will by that means be ascertained.

2. When the weight W lies between the fulcrum G and the power P, (fig. 2.) This kind includes the crow in its more general application, the baker's and druggist's knife, the common door, the wheel-barrow, nut-crackers, and oars. In this, as well as the former, the advantage gained is as the distance of the power to the distance of the weight from the fulcrum: for the respective velocities of the power and weights are in that proportion; and they will balance each other when the intensity of the power, multiplied by its distance, is equal to the intensity of the weight multiplied by its distance. Thus, if A B, be a lever on which the weight W of 6 pounds hangs at the distance of 1 inch from the prop G, and a power P, equal to the weight of 1 ounce, hangs at the end B, 6 inches from G by the cord C D going over the fixed pulley E, the power will merely support the weight: and a small addition to the power will raise the weight 1 inch for every 6 inches that the power descends. This lever shews the reason why two men carrying a burden upon a stick between them, bear unequal shares of the burden in the inverse proportion of their distances from it. For the nearer either of them is to the burden, the greater share he bears of it: and if he goes directly under it, he bears the whole. So if one man be at G, and the other at B, having a pole or stick A B resting on their respective shoulders; if the burden be five times nearer G than A, the man G will bear five times as much as B. If the load G be only placed upon the pole P W, as in fig. 20, a vertical from the centre of gravity G, will in going up a hill divide the space unequally at C, and the lower person must therefore suffer a greater strain. Two horses of unequal strength may yet be yoked to draw equally, by a proportionate division of the bar. This is partly effected in the ordinary way, by attaching the perch to a short projection from the middle of the bar. To range a number of men along the arms of a pole, for the purpose of transporting heavy loads, is very unskilful, though frequently done in this country. Those who are nearest must evidently take the greatest share of the burden, while the remote bearers have not the means of exerting their strength. The method practised in the East is much preferable, the strain being successively subdivided by a system of levers crossing each other.

3. When the power P is applied (fig. 3) between the fulcrum E and the weight W. To this kind belong the sheep-shears. It has a mechanical disadvantage, but admits of a proportionally wider motion. The bones of animals are therefore levers generally of this sort, pulled by the moderate contraction of muscles inserted nearer their joints or centre of motion than the centre of gravity of the weight to be raised. That there may be a balance in this lever, between the power and the weight, the intensity of the power must exceed the intensity of the weight just as much as the distance of the weight from the prop exceeds the distance of the power. For example, 1 pound placed three times as far from the prop E as the power P acts at F, by the cord C going over the fixed pulley D, the power must be equal to 3 lbs. to support the weight of 1 lb. Upon the principle of this lever, we see men raise ladders against a wall, and also the wheels of a clock move, because their moving power acts upon them near the centre of motion by means of a small pinion which is the fulcrum.

*The Bent Lever*, differs in nothing from the first, except in being bent for the sake of convenience. A B C, fig. 4, is a lever of this sort, bent at C, which is its fulcrum or centre of motion. P is the power acting upon the longer arm A C at F, by means of the cord D E going over the pulley G; and W is a weight or resistance acting upon the end B of the shorter arm C B. If the power is to the weight as C B : C F, they are in equilibrium; for if $W = 5$ lbs. acting at the distance of 1 foot from the centre of motion C, and $P = 1$ lb. acting at F, 5 feet from the centre C, the power and weight will just balance each other.

*The Universal Lever*, is occasionally used for raising weights, but more commonly for dragging logs to the saw-pit. This is effected by annexing to the end of the short arm two claws, which work alternately in the teeth of a rachet wheel. In fact, the wheel and pinion are but an extension of the lever.

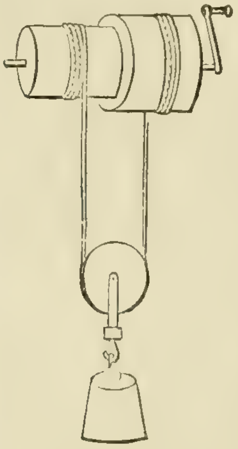
One of the most ordinary and yet useful applications of the lever, is to weigh substances, or to compare their weights by means of a standard, as shewn in fig. 5, where the common balance, though less expeditious than the steelyard, as shewn in fig. 6, is yet capable of greater accuracy. As it has equal arms C E, D E, it requires a series of intermediate weights, which are thrown into either scale A or B, and the whole is suspended on the pivot or fulcrum E. H is a mere hook by which to suspend the machine. For philosophical purposes, the easiest way is to reckon always by grains. The geometrical progression 1, 2, 4, 8, 16, 32, 64, &c. forms the simplest arrangement; but it will be found more convenient to follow the decimal division, and the successive sets of 1, 2, 3, and 4; 10, 20, 30, and 40; 100, 200, 300, and 400; 1000, 2000, 3000, and 4000, &c. would save much trouble in adding up the weights.

*A False Balance* has one arm somewhat longer than the other. But the fraud is easily detected, by interchanging the places of the weight, and the substance to be weighed; for the weight assigned will then be diminished, in the same proportion as it was before augmented. It perhaps deserves remark, that the true weight is rather less than half the sum of those opposite indications. Suppose B D (fig. 21) to represent the true weight, and let B D be to B A in the ratio of the arms of the fraudulent balance; having completed the semicircle, it is evident that A B will indicate the weight of the substance when placed in the scale of the longer arm, and B C its weight when suspended from the shorter arm. But B D is less than the radius, or the arithmetical mean between A B and B C. Since, from the property of the semicircle, B D is a mean proportional or geometrical mean between A B and B C, the true weight of any body might be discovered even by means of a false balance. Let it be weighed first in one scale, and then in the other; and, the results being multiplied together, the square root of their product will give the accurate value. Every correct balance must, therefore, have arms of precisely equal lengths, or have its fulcrum placed equally distant from the extreme points from which the scales are suspended. But the delicacy of the instrument depends on the proximity of its fulcrum to the straight line joining those two points. To preserve a stable equilibrium, however, it must occupy a position somewhat above that line. The beam should be strong and light, its preferable form consisting hence of two hollow cones: it should turn with a fine knife-edge upon a plate of agate, polished crystal, or hard steel; and the scales should likewise be hooked from sharp edges. The sensibility is further augmented, and the risk of injury obviated, by various other contrivances, some of which we have already noticed in treating upon this useful domestic machine.

*The Wheel and Axle*, (fig. 7,) is reckoned the next mechanical power, and it consists merely of a wheel A B attached to a small cylinder C D moving about the same centre; the power is applied to the circumference of the wheel, and the weight W to be raised has a cord K lapped about the cylinder. This instrument may hence be regarded as a continued lever. The power is, therefore, to the weight, as the radius of the axle is to that of the wheel; or, if the principle of virtual velocities be preferred, the power and weight are inversely as the circumferences of the wheel and of its axle. If the circumference of the wheel be eight times that of the axle, then a power P = 1 lb. hanging by the cord I, which laps over the wheel, will balance a weight W = 8 lbs. hanging by the rope K, which goes round the axle. If spokes S, S, S, or arms, be applied to the wheel, the circumference described by these must be considered as the circle of action. In this sort of machines it is requisite to have a ratchet wheel on the end of the axle C, with a catch to fall into its teeth; which will at any time support the weight, and keep it from descending, if the person who turns the handle should, through inadvertency or carelessness, quit his hold while the weight is raising. Thus, by this means, the danger is prevented which might otherwise happen by the running down of the weight when left at liberty.

As varieties of the same instrument, we may name the *Capstan* or *Windlass*, and the *Common Gin*. In the latter, the rope which draws up the weight is wound about a drum, with a long projecting arm, which a horse puts in motion by treading round a circular path. Of a similar nature is the crane, driven by men or cattle, walking within its circumference; but here the purchase is only in the ratio of the distance of the point of impulsion from a vertical through the centre of the wheel, to the radius of the axle. The wheel and axle may turn also on different centres, and have their circumferences connected in mutual action, either by means of a belt or strap, or by the indentation of a system of cogs or teeth. This arrangement is usually called *Wheel and Pinion*. The wheel has sometimes its axle of a tapered or conical shape, which gives it a varying purchase. This construction is adopted in the fusee of a watch, and is likewise employed advantageously in raising minerals, by an uniform pull from very deep pits, the rope at its greatest length being coiled about the narrow end of the axle, and advancing towards the wide end as it shortens.

*The Double Capstan* is a very ingenious contrivance, originally brought from China, for augmenting in any degree the efficacy of the wheel and axle, without reducing its strength. It consists of two conjoined cylinders of nearly equal diameters, turning about the same axis, the weight being supported by the loop of a very long cord, of which one end uncoils from the smaller cylinder, while the other end laps constantly about the larger cylinder, as represented in the annexed figure. The elevation of the weight at each revolution is therefore equal to half the difference between the two circumferences, and the effect of the arrangement is the same as if the cord sustaining the weight had been wound about a cylinder, which has a circumference merely equal to that quantity. The mechanical advantage of the instrument, combined with its pulley, is hence in the ratio of the diameter of the larger cylinder to half its excess above that of the smaller one. Nearly the same effect is procured, by employing a single conical axle; one part of the train of cord unrolling itself from the smaller end, while the other part is coiled up towards the larger end.



*The Pulley* consists either of one moveable pulley, or a system of pulleys; some in a block or case which is fixed, and others in a block which is moveable, and rises with the weight. For though a single pulley that only turns on its axis, and moves not out of its place, may serve to change the direction of the power, yet it can give no mechanical advantage thereto; but is only as the beam of a balance, whose arms are of equal length and weight. Thus A, fig. 8, is a single pulley, and if it support the equal weights P and W, the cord B B to which they are appended, is equally stretched throughout, and the pulley A sustains both the weights, or is drawn with a force equal to twice P. It is properly but another form of the balance.

In the pulley, fig. 8, No. 2, a power of one (P 1,) will sustain twice its weight, (W 2,) the cord *b* B being stretched with a power of 1, and the part from A to P with an equal power.

In a combination of three moveable pulleys, A B C, fig. 9, connected by three distinct cords, each fastened at one end to an immoveable block above, the power of the whole is discovered by supposing two such weights, P and W, suspended so as to keep the machine in equilibrio, and then beginning with the least weight or power P, and considering what force each separate pulley sustains. Thus if P be one pound, the cord which sustains it acts at its other end upon the fixed block above, and is consequently re-acted upon by a force equal to one pound; and the pulley A, as in fig. 8, is drawn with a force equal to two pounds. By tracing the second cord in the same manner, it will appear that the pulley B is drawn with twice the force of A, or four pounds; and C is drawn with twice the force of B, or 8 pounds. So that the purchase of this machine is such, that the weight W has 8 times the power of P.

The velocity of the weight to that of the power is (in a similar way of arguing) thus: if P descend 8 inches, A will ascend 4; B, 2; and C or W, 1 inch, so that the velocities are reciprocally as the power and weight.

Another combination of pulleys, whereof two, A and B, fig. 10, run in the fixed block X; and two others C and D, in a moveable block, which raise the weight W; by pulling the cord at P, which goes successively over the pulleys A, D, B, C, and is fastened to the fixed blocks. The purchase of this machine is known by considering that the cord is usually stretched throughout by putting two such weights, P and W, as will counterpoise each other: for P is sustained by the single cord, and W by four folds of the same, viz. by the parts $o, s, u, k,$; so that if P be one pound, W will be four pounds.

The velocity of the power is to that of the weight as four to one, for if P descend four inches, the parts of the cord at $k$ will ascend towards $e$ four inches, and all the other parts of the cord, from the pulley C., will equally follow each other, and C or W will ascend one inch towards $s$; or the four parts of the cord $o, s, u, k$, will each be shortened one inch.

In like manner may the purchase of any other combination of pulleys be determined: and it will always happen, that the *momenta* of the weight and power will be equal, as in other mechanical powers. That is, if any power will raise one pound with a certain velocity, the same power will raise two pounds with half that velocity, or one hundred pounds with one hundredth part of that velocity, &c. But as a system of pulleys has no great weight, and lies in a small compass, it is easily carried about; and can be applied, in a great many cases, for raising weights, where other engines cannot; but they have a great deal of friction on three accounts:—1. Because the diameters of their axes bear a very considerable proportion to their own diameters. 2. Because in working they are apt to rub against one another, or against the sides of the blocks. 3. Because of the stiffness of the ropes that pass over and under them.

*The Inclined Plane* is chiefly employed to facilitate excavations, and to raise the materials in buildings; and the advantage gained by it is as great as its length exceeds its perpendicular height. Let A B, fig. 11, be a plane parallel to the horizon, and C D a plane inclined to it; and suppose the whole length C D to be three times as great as the perpendicular height G$f$F. In this case the cylinder E will be supported upon the plane C D, and kept from rolling down upon it, by a power equal to a third part of the weight of the cylinder. Therefore, a weight may be rolled up this inclined plane with a third part of the power which would be sufficient to draw it up by the side of an upright wall. If the plane was four times as long as it is high, a fourth part of the power would be sufficient; and so on in proportion. Suppose a man has occasion to set a weight upon an eminence, and the weight is so great that he cannot lift it by his natural strength, he will take a long stout plank, or something equivalent thereto, and setting it sloping, will push the weight before him up the plank, to the place designed to set it in; and such plank, or other contrivance like it, is an inclined plane. Now it is evident that the shorter this inclined plane is, the steeper is the ascent; and the longer the plane is, the ascent must be the easier. It is plain also, that it is much easier to push a rolling weight E along a level A B, fig. 12, up a hill D C, fig. 11, that rises gently, than up a hill A B, fig. 13, which is very steep.

The force wherewith a rolling body descends upon an inclined plane, is to the force of its absolute gravity, by which it would descend perpendicularly in a free space, as the height of the plane is to its length. For suppose the plane A B, fig. 12, to be parallel to the horizon, the cylinder will keep at rest on any part of the plane where it is laid. If the plane be so elevated, that its perpendicular height from D, fig. 13, is equal to half its length AB, the cylinder C will roll down upon the plane with a force equal to half its weight; for it would require a power (acting in the direction of A B) equal to half its weight, to keep it from rolling. If the plane DB, fig. 14, be elevated, so as to be perpendicular to the horizon, the cylinder C would descend with its whole force of gravity, because the plane contributes nothing to its support or hinderance; and therefore it would require a power equal to its whole weight to keep it from descending. To the inclined plane may be reduced all hatchets, chisels, &c.

*Of the Wedge.*—The fifth mechanical power or machine is the wedge, which may be considered as two equally inclined planes D E F and C E F, joined together at their bases $e$ E F O, fig. 15; then D C is the whole thickness of the wedge at its back A B C D where the power is applied; E F is the depth or height of the wedge; D F the length of one of its sides, equal to C F, the length of the other side; and O F is its sharp edge, which is entered into the wood intended to be split, by the force of a hammer or mallet striking perpendicularly on its back. Thus, A B, fig. 16, is a wedge driven into the cleft C E D of the wood F G. When the wood does not cleave at any distance before the wedge, there will be an equilibrium between the power impelling the wedge downward, and the resistance of the wood acting against the two sides of the wedge; when the power is to the resistance as half the thickness of the wedge at its back is to the length of either of its sides: because the resistance then acts perpendicular to the sides of the wedges. But when the resistance on each side acts parallel to the back, the power that balances the resistances on both sides will be as the length of the whole back of the wedge is to double its perpendicular height. When the wood cleaves at any distance before the wedge, (as it generally does,) the power impelling the wedge will not be to the resistance of the wood as the length of the back of the wedge is to the length of both its sides, but as half the length of the back is to the length of either side of the cleft, estimated from the top or acting part of the wedge. For if we suppose the wedge to be lengthened down from the top C D, to the bottom of the cleft at E, the same proportion will hold; namely, that the power will be to the resistance as half the length of the back of the wedge is to the length of either of its sides: or, which amounts to the same thing, as the whole length of the back is to the length of both the sides.

The wedge is a mechanical power of singular efficacy, and the percussion by which its action is obtained, is precisely that force which we can with the greatest convenience almost indefinitely increase. By means of the wedge, the walls of houses may be propped, rocks split, and the heaviest ships raised up,—operations to which the lever, the wheel and axle, and the pulley, are either ill adapted, or entirely incompetent. To the wedge are referred the axe, the spade, chisels, needles, knives, punches, and, in short, all instruments which, beginning with edges or points, grow gradually thicker. A saw is a number of chisels fixed in a line; and a knife, if its edge be examined with a microscope, will be found to be only a fine saw.

*Of the Screw.*—The sixth and last mechanical power which we have to notice, is the screw. The screw, strictly speaking, consists of two parts, which work within each other. One of these parts, and which is always meant when the word screw is used alone, is a *solid* cylinder, on the circumference of which is cut a spiral groove;—specifically called an *outside* or *convex* screw. The other part is a *hollow* cylinder, or at least, whatever its external form may be, it contains a cylindrical hole, within which is cut a spiral groove corresponding to that of the convex screw, which can be turned within it, and the spiral projections of one lock into the spiral hollows of the other. For the sake of necessary contradistinction, this latter part is called an *inside*, a *concave*, or *socket* screw, when spoken of generally, without reference to any other use than its principal one, of an indispensable companion to the convex screw; but when it consists of a small piece of metal, as for drawing tight bolts of any description, it is most commonly called a *nut*; and when it is of considerable size, as for a large press or vice, it is usually called a *box*. The *thread* of a screw is its spiral projection; the *pace* or *step* of a screw is the *distance* between the threads; and the groove or gorge is the hollow between the threads.

To obtain an idea of the nature of the screw, and of its affinity to the inclined plane, cut a piece of paper in the form of an inclined plane, or half wedge, as A B C, fig. 17, and then wrap it round a cylinder, fig. 18: the edge of this plane or paper will form a spiral round the cylinder, which will give the thread of the screw. A screw is seldom used without the application of a lever to assist in turning it: it then becomes a compound machine of great force, either in compressing the parts of bodies together, or in raising great weights. As the lever or winch must turn the cylinder once round before the weight or resistance can be moved from one spiral winding to another, or before the screw working in its box can rise or sink the distance between the threads, as from $a$ to $b$, therefore as much as the circumference of the circle described by the lever is greater than the pace of the screw, or distance between the threads. so much does the force of the screw exceed the motive force. For example, suppose the pace or distance of the threads to be half an inch, and the length of the lever 12 inches, the circle described by the extremity of the lever where the power acts, will be about 76 inches, or 152 half inches, consequently, 152 times as great as the distance between two contiguous threads; therefore if the intensity of the power at the end of the lever be equal to one pound, that single pound will balance 152 pounds acting against the screw. If as much additional force be exerted as is sufficient to overcome the friction, the 152 pounds may be raised; and the velocity of the power will be to the velocity of the weight as 152 to 1. Hence we may clearly perceive, that the longer the lever, and the nearer the threads to one another, so much the greater is the force of the screw. The friction of the screw is very great, but we are indebted to this circumstance for a peculiar advantage in the use of this machine, which will sustain a weight, or press upon a body against which it is driven, after the power is removed or ceases to act. To enumerate all the uses of the screw, would be impossible. Among other purposes, it is applied to great advantage for measuring or subdividing small spaces; when thus applied it is called a *micrometer*, which may be made to indicate on an index plate, a portion of a turn, advancing the screw less than the fifty-thousandth part of an inch.

The threads of screws are differently formed, according to the materials of which they are made, or the use for which they are intended. The threads of wooden screws are generally angular, that they may rest upon a broad base, and thereby have their strength increased to the utmost. Small screws, whatever material they are made of, are generally angular also, not only for the same reason as the wooden ones, but because the angular thread is the most easily made. The metal screws which are used for large presses, vices, &c. have generally a square thread, a form which gives great steadiness of motion. A thread of which the sides are parallel, and the top and bottom a little rounded, is perhaps the most perfect of all forms. In the common screw, to which the preceding observations are exclusively applicable, the threads are one continued spiral, from one end to the other; but where there are two or more serate spirals running up together, as in the worm of a jack, or the principal screw of a common printing press, the descent of the screw in a revolution will be proportionately increased; and therefore whatever be the number of the spirals, they must, in calculating the power, be measured and reckoned as one thread.

*The Endless Screw.*—A screw is sometimes cut on an axle, to serve as a pinion, and by working in the circumference of a wheel; it is then called an *endless screw*, because it may be turned perpetually without advancing or receding, that is, without any other motion than a rotatory one. The threads of this screw are of the square form, and fit exactly into the spaces between the teeth of a wheel, which teeth are cut obliquely, to answer the threads. When the endless screw has been turned once round, the wheel has only made a portion of a turn equal to the distance between one of its threads; that is, the wheel has moved one tooth; and therefore the number of its teeth is always the same as the number of the revolutions made by the screw before it once turned round.

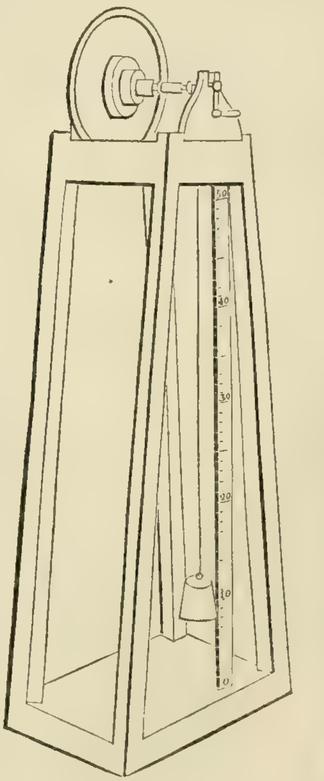
The construction and mechanical advantage gained by this screw may be best illustrated by a figure; let the wheel C, fig. 19, have an endless screw *a b* working in the teeth of the wheel D, which suppose to be 48 in number. It is plain, that for every time the wheel C and screw *a b* are turned round by the winch A, the wheel D will be moved one tooth by the screw, and therefore, in 48 revolutions of the winch, the wheel D will be turned once round. Then, if the circumference of a circle, described by the handle of the winch A, be equal to the circumference of a groove *e* round the wheel D, the velocity of the handle will be 48 times as great as the velocity of any given point in the groove. Consequently, if a line G goes round the groove *e*, and has a weight of 48 pounds hung to it below the pedestal E F, a power equal to one pound at the handle will balance and support the weight. To prove this by experiment, let the circumferences of the grooves of the wheels C and D be equal to one another; and then if a weight A, of one pound, be suspended by a line going round the groove of the wheel C, it will balance a weight of 48 pounds hanging by the line G; and a small addition to the weight H, will cause it to descend, and so raise up the other weight.

If a line G, instead of going round the groove *e* of the wheel D, goes round its axle, 1, the power of the machine will be as much increased as the circumference of the groove *e* exceeds the circumference of the axle: which supposing it to be six times, then one pound at H will balance six times 48, or 288 pounds, hung to the line on the axle; and hence the power or advantage of this machine will be as 288 to 1. That is to say, a man, who by his natural strength could lift an hundred weight, will be able to raise 288 by this engine. The use of the endless screw affords a very ready means of greatly diminishing a rotatory motion, and accomplishes at once what would otherwise require the intervention of two or three wheels; and although it operates slowly by a sliding motion, it has not probably more friction than any of the less simple combinations which might be employed to effect the same object. It possesses the advantage too, of moving a wheel with much more steadiness than a pinion, when the workmanship of both is of equal quality. This circumstance is not so much regarded by mechanics as perhaps it ought, and therefore the endless screw is often not used when it would be advantageous. The principal restriction to the use of this screw is, its being so liable to wear when its motion is very rapid: a rapid motion, therefore, should not be assigned to it, unless it be made of hardened steel, when the objection will be less forcible.

The coining engine consists of a screw carrying ponderous arms. The impulsion accumulated by the swing produces a stroke similar to the concentrator of force; but the violence of the blow is softened, and the shock partly consumed, by the prolonged friction of the slanting grooves of the screw, by which the stamper advances to the die.

As the endless screw, working in the teeth of a wheel, has its energy multiplied by their number, it is evident that it may act at once on two ratchet wheels divided almost alike, the difference in breadth between the parallel teeth being the space of exertion. By such a contrivance, which also reckons the revolutions, the mechanical purchase might be carried to any extent.

*The Concentrator of Force*, an engine that exhibits in a striking manner the accumulation and transfer of impulsion among bodies, may be regarded as, next to Atwood's ingenious machine, an important addition to illustrative philosophical apparatus, since it not only sheds a clear light on some abstruse parts of mechanical theory; but may with advantage be directed, in a variety of important cases, to the practice of the arts. The concentrator consists of a ponderous wheel, composed of a thin circle of iron, loaded at the circumference with a broad swelling ring of lead, and fixed to a strong steel axle. To this axle is likewise attached several short cylinders, of different diameters, the smallest formed of brass, and divided into two parts, that are capable of locking together at pleasure. The axle, placed in a horizontal position, moves upon gudgeons on the top of a high solid frame; and the machine may be set in motion by turning a winch, or by the descent of a small weight fastened to a silk line, which passes over a pulley, and is lapped round one of the barrels. The fig. represents one of the best models that has yet been used, the frame being five feet in height; the wheel has about 18 pounds weight, and is 17 inches



in diameter, while the diameters of the successive barrels are only 6, 4 and 2 inches. The principal application of this engine is to raise from its platform any great weight. If 1 pound, for instance, in descending through thirty feet, gradually communicate its impression to the wheel, and, the instant it reaches the ground, the detached part of the brass barrel should lock, and catch hold of the loop of a cord holding half a hundred weight, or 56 pounds, this mass will be almost immediately lifted up near 6 inches, and there suspended. But what is remarkable, and appears at first sight paradoxical, the effect is precisely the same about whatever barrel the line be wound. The result is quite altered, when different descending weights are used, the elevation produced being always proportional to them. Thus, the descent of 2 and 4 pounds through 30 feet, will raise 56 pounds to nearly 1 and 2 feet.

It is not difficult to explain generally these effects. Let the descending power be very small in comparison with the weight of the ponderous wheel, and suppose its action at first to be exerted at the rim. This rim, in which is condensed the entire mass, will now describe a space equal to the measure of descent, and the whole power may be considered as inciting its revolution. Consequently the square of the velocity acquired by the wheel must be proportional to the descending power multiplied into the space through which it falls. When the accelerating force acts upon a barrel smaller than the wheel, the energy exerted at the rim is proportionally diminished, but the space described by it is augmented in the same ratio, and therefore the square of the velocity resulting from those combined causes will continue unaltered. The square of the velocity, or measure of impulsion, is extinguished by the efforts expended in raising the weight; wherefore the power multiplied into the quantity of descent is = the weight × into its corresponding ascent. Hence the power and the weight are inversely proportional to the spaces which they severally describe.

Leslie, who has very fully examined this matter, gives a very rigid formula in exemplification of this principle, from which he shews that the fall of 2 lbs. through 30 feet would lift 500 lbs. over 1 inch and a third part; and if the force be accumulated, the concentrator will prove sufficient to start the greatest load, or overcome the most powerful obstacle. Instead of raising great weights, the concentrator might be adapted to tear asunder thick wires or metallic rods. The power exerted will then be inversely as the spaces through which those rods stretch, before they suffer fracture. The effects will consequently be augmented, by shortening the lengths of the rods. To the bottom of the engine, screw a strong bar above 4 feet in height, and to this fasten rods from 6 inches to a foot long. If the limit of extension, which precedes the final disruption, were only half an inch, the power exerted, though produced by the descent of a single pound, would amount to about 1500 lb. A rigid and unyielding body is hence the most easily torn or broken. But the impetus accumulated by the concentrator may be wholly consumed, in merely stretching a very elastic substance of sufficient length. If a light contorted spring, for instance, be opposed to the rotation of the mass, it will, by its large though languid extension, gradually destroy the motive energy. A thick woollen cord, loosely plaited, and tied to a ring at the bottom of the machine, will produce a similar effect. A slender hempen string, which has little of a stretching quality, may still serve the same purpose, if it be taken of an adequate length. It is only required that half the final strain multiplied into the corresponding extension should be equal to the product of the falling weight by its quantity of descent. A tension of 60 lb., acting through a height of one foot, would be sufficient to muffle and extinguish the momentum of rotation generated by the descent of one pound through 30 feet. To produce this effect, therefore, it is only wanted to select such a length of cord as will extend one foot, by the application of a strain of 120 lbs. A more slender substance, if proportionally more stretching, would have the same effect. In either case, a weight exceeding the absolute tension, and attached to the end of the string, would not, during the moderated consumption of the shock, be stirred in the slightest degree from its place. The strength of a cord depends on its thickness, but the power to resist impulsion is determined by its elasticity and its length. This principle, which has been much overlooked, enters largely into the consideration of practical mechanics. Hence the practice of stemming a ship's way into a harbour by the friction of a long rope, the momentum being thus gradually spent. A short rope, firmly fastened to the pier head, so far from staying the vessel, would instantly snap. For the same reason, a ship riding at anchor is obliged to lengthen her cables. When these are composed of chains, the tension resulting from a diminution of curvature is precisely the same as if a contractile force had been exerted. It is perhaps a general error in civil architecture to aim at mere solidity. Lightness and elasticity combined will often resist the shocks of ages, while stiff and ponderous materials are crumbled into ruins.

If the barrels be of 2 and 3 inches radii, then will the time of generating the impulsion be compounded of the inverse ratio of the radius of the barrel, and the inverse subduplicate ratio of the falling body, with the direct subduplicate ratio of the space of descent; while the time of expanding this impulsion is inversely as the weight to be raised, and directly in the subduplicate ratio of the falling body and of its descent. Thus one pound having a line curled about the smallest barrel, will descend through 30 feet in $\frac{3}{4}\sqrt{(18.30)}$ seconds, or 46½″; connected with the middle barrel it would descend in 23¼″; but applied to the largest barrel it would only require 15½″. The succeeding act of lifting 112 lbs. will occupy five-sixths of a second. Also, the impulsion which required 46½″ to accumulate, exerts in ascension a strain of 1500 lbs., which is sufficient to tear a rod of metal asunder in less than the thirtieth part of a second; for the greater the weight to be raised, the more rapid is the act of ascension; and it is the same thing, whether an obstacle be overcome, or a disruption effected. The slowness with which this impulsive energy collects, is remarkably contrasted with the rapidity of its subsequent discharge. The greatest effects may be concentrated within such a portion of time as eludes the observation of the senses, and appears really instantaneous.

The Concentrator of force thus finely elucidates the acquisition and the transfer of impulsive energy. The same accumulated momentum produces diversified effects, according to the way in which it is disposed. It will raise a ponderous mass, tear asunder a solid body, or will expend all its action in merely stretching a substance of a very distensible quality. These different purposes are attained in the operations of the mechanical arts; but sound theory is yet required to guide and improve the practice. This engine, constructed on a large scale, might hence, with obvious advantage, be adopted as a most powerful auxiliary in various operations of art. Many situations occur which require an immense effort to be made on a sudden, and within a very limited space. This can be accomplished only by storing up, as it were, a magazine of force, which may be opened and discharged at some precise moment. Even moderate animal exertion, if applied during any considerable time, will communicate to the concentrator an impulsion sufficient to burst the firmest obstacles, and to lift, through a short space, the most enormous loads.

This engine involves likewise the theory of the *Fly* which is annexed to various machines, not to augment their power, but merely to equalize their motion. The variable inciting forces are thus, by the intervention of a heavy wheel, blended together in creating one great momentum, which afterwards maintains a nearly uniform action. The use of the fly in mechanics hence resembles a reservoir, which collects the intermitting currents, and dispenses its water in a regular stream.

Though it is evident, from the foregoing principles, that any one of the mechanical powers is capable of overcoming the greatest possible resistance, in theory; yet, in practice, if used singly for producing very great effects, they would frequently be so unwieldy and unmanageable, as to render it impossible to apply them. For this reason, it is generally found more advantageous to combine them together; by which means the power is more easily applied, and many other advantages are obtained. Of the various machines which have been contrived to illustrate the simple mechanical powers, or to illustrate their effects, we select the following:—

*Machine in which all the Mechanical powers are combined.*—The lever A B, plate II. fig. 1, whose centre of motion is C, is fixed to the endless screw D E, which drives the wheel and axle F H G. Round the axle G is coiled a rope G H I, passing round the four pulleys K, L, *m*, *n*, and fixed to a hook at *m* on the lower block, which carries the weight W. When equal weights are suspended on the lever at equal distances from the fulcrum C, the lever becomes a balance, and the wedge and inclined plane are evidently included in the endless screw D E. If the wheel F has thirty teeth, if the lever A B is equal to twice the diameter of the wheel F H, and if the diameter of the axle G is one-tenth of the diameter of the wheel, a power of 1 exerted at P will raise a weight of 2400 suspended at the lower block of the four pulleys.

*Machine for illustrating the Theory of the Wedge.*—This machine is represented in fig. 2, where K I L M and L M N O are two flat pieces of wood joined together by a hinge at L M; P is a graduated arch on which these pieces of wood can be moved so as to subtend any angle not greater than 60°, and *a*, *b*, two screws for fixing them at the required angle. The back of the wedge will therefore be represented by I K N O, its sharp edge by L M, and its two sides by K I L M, L M N O. The weight *p* suspended to the wedge by the hook M, and the weight of the wedge itself, may be considered as the force employed to drive the wedge. The wooden cylinders A B, C D, have their extremities made like two flat circular plates, to prevent the wedge from slipping off at one side. To the pivots of these cylinders, two of which are represented at *e* and *f*, are fastened the cords *e*W, *f*U, C V, A X, which passing over the pulleys U, V, X, W, are fastened to the two bars *uv*, *xw*, on which any equal weights Y, Z, may be hung at pleasure. The tendency of these weights is evidently to draw the cylinders towards each other, and they may therefore be regarded as the resistance of the wood acting against the sides of the wedge. The cylinders themselves are suspended by their pivots to the threads E, F, G, H, which may be fixed to the ceiling of the room, or to the horizontal beam of a frame made on purpose. By placing various equal weights at Y and Z, it may be easy to determine the proportion between the power and the resistance when the wedge is in equilibrio. In this machine the impelling power is the pressure of the weight *p*, whereas, in the real wedge, the impelling power is always an impulsive force, which is infinitely more powerful.

*Machine for trying the Strength of Material.*—The piece of wood, whose strength is to be tried, is represented by E F, fig. 3, and the force is applied to it by means of the winch A, which winds up the rope B C, passing over the pulley *n*, and below the pulley *m*, and attached to the point D of the beam E F. The pulleys slide on two parallel bars fixed in a frame, held down by a projecting point at G, of the lever G R, which is graduated like a steelyard, and measures the force employed. The beam E F is held by a double vice I K with four screws, two of which are invisible. When a wire is to be torn, it is fixed to the cross bar L M; and when any body is to be crushed, it must be placed beneath the lever N O, the rope B C being fixed to the hook N, and the end O being held down by the click which acts on the double ratchet O P. The lever is double from O to Q, and acts on the body by a loop fixed to it by a pin, from which this drawing and description are taken.

COMPOUND MACHINES, AND THE CONSTRUCTION OF MACHINERY.—In this article we shall confine ourselves strictly to its title, as we have under their respective names described and illustrated the *Centre of Gravity of Bodies*, *Friction*, *Motion*, *Inertia*, &c.—Compound machines are all such as consist of a combination of the several simple machines, or mechanical powers, of which a description has been already given. To the varieties which appear under all the forms of association, scarcely any boundaries can be assigned; and as science advances, the number will continue to increase till it approximates to infinity. These compound machines are again classed under different denominations, according to the agents by which they are put in motion, the purposes they are intended to effect, or the art in which they are employed. Hence we have hydraulic, pneumatic, military, and architectural machines, with a variety of others, which are elsewhere described under their respective heads.

The impelled and working parts of a machine are generally connected by means of toothed wheels, so constructed as to produce the surest motion and most regular velocity. But it happens in most machines, that from their very construction, as well as from inequalities in the resistance to be overcome, and the nature of the impelling power, the momenta of their parts proving insufficient to equalize these irregularities, *fly wheels* are adopted for regulating and rendering uniform their variable movements. *See* FLY WHEEL.

*First Movers of Machinery* are: 1. Animal strength, used as a moving power, may be employed in turning a windlass by a winch, in carrying burdens, or drawing, as the horse; 2. The application of wind, as in the wind mill, which see;—3. The impelling power of water for mills;—and the tremenduous force of steam.

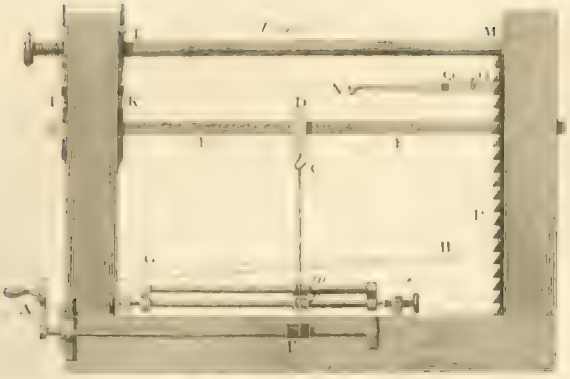
TABLE *of the Strength of Men, according to different Authors.*

| Number of Pounds raised. | Height to which the Weight was raised. | Time employed in raising each Lift. | Duration of the Labour. | Authorities. |
|---|---|---|---|---|
| 1000 | 180 | 60 minutes, | | Euler. |
| 60 French. | 1 French. | 1 second, | 8 hours, | Bernouilli. |
| 25 | 200 | 145 secs | | Amontons. |
| 170 | 1 | 1 second, | half an hour | Coulomb. |
| 1000 | 330 | 60 minutes, | | Desaguliers |
| 1000 | 225 | 60 minutes, | | Smeaton. |
| 30 | 3½ | 1 second, | 10 hours, | Emerson. |
| 29 or 30 | 2·45 | 1 second, | | Schulze. |

According to Amontons, a man weighing 133 pounds French, ascended 52 feet French by steps in 34 seconds, but was completely exhausted. The same author informs us that a sawer made 200 strokes of 18 inches French each, with a force of 25 pounds, in 145 seconds; but that he could not have continued the exertion above three minutes.

It appears from the observations of Desaguliers, that an ordinary man can, for the space of ten hours, turn a winch with a force of 30 pounds, and with a velocity of two feet and a half per second; and that two men working at a windlass with handles at right angles to each other, can raise 70 pounds more easily than one man can raise 30. The reason of this is, that when there is only one man, he exerts variable efforts at different positions of the handle, and therefore the motion of the windlass is irregular; whereas in the case of two men, with handles at right angles, the effect of the one man is greatest when the effect of the other is least, and therefore the motion of the machine is more uniform, and will perform more work. Desaguliers also found, that a man may exert a force of 80 pounds with a fly when the motion is pretty quick, and that, by means of a good common pump, he may raise a hogshead of water 10 feet high in a minute, and continue the exertion during a whole day.

A variety of interesting experiments upon the force of men were made by the learned M. Coulomb. He found that the quantity of action of a man who ascended stairs with nothing but his own weight, was double that of a man loaded with 223 pounds avoirdupois, both of them continuing the exertion for a day. In this case the total or absolute effect of the unloaded man is the greatest possible; but the useful effect which he produces is nothing. In the same way, if he were loaded to such a degree that he was almost incapable of moving, the useful effect would be nothing. Hence there is a certain load with which the man will produce the greatest useful effect. This load M. Coulomb found to be 173·8 pounds avoirdupois, upon the supposition that the man is to ascend stairs, and continue the exertion during a whole day. When thus loaded, the quantity of action exerted by the labourer is equivalent to 183·66 pounds avoirdupois raised through 3282 feet. This method of working is however attended with a loss of three-fourths of the total action of the workman.—It appears also from Coulomb's experiments, that a man going up stairs for a day raises 205 chiliogrammes (a chiliogramme is equal to three ounces five drams avoirdupois) to the height of a chiliometre (a chiliometre is equal to 39571 English inches); that a man carrying wood up



Machine to measure the Strength of Materials

Fig. 2

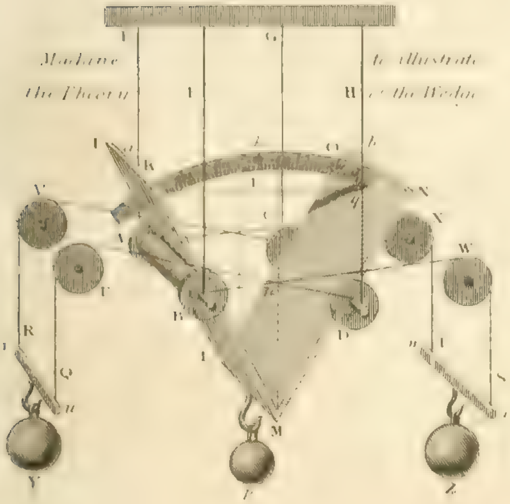
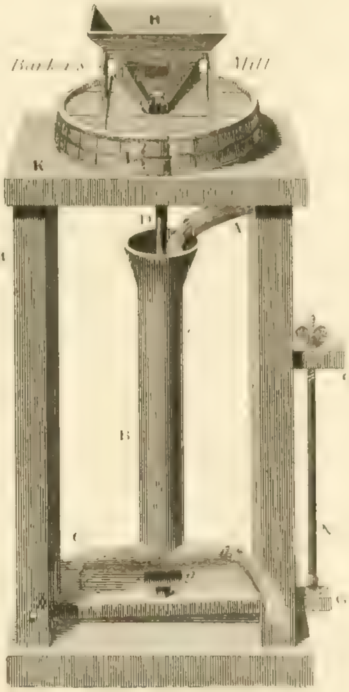
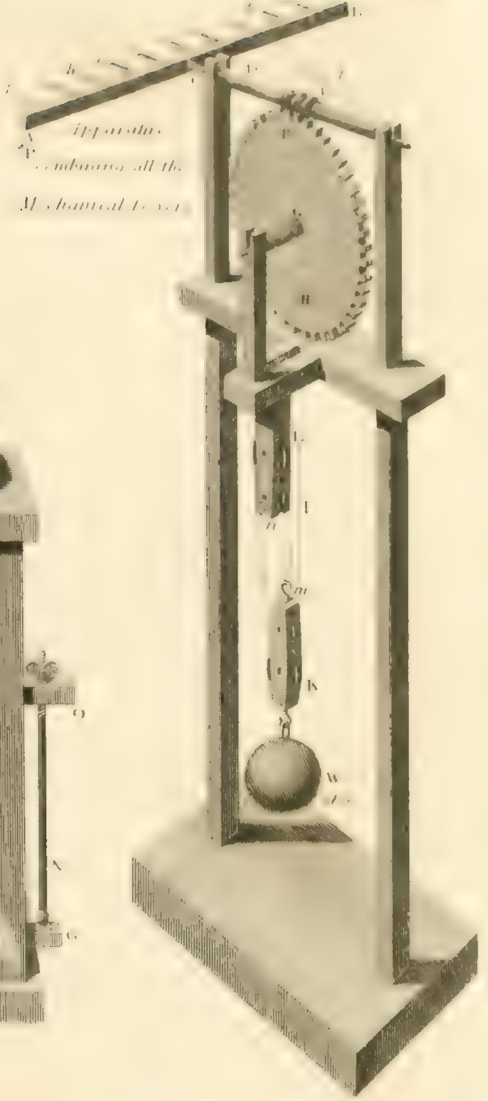


Fig. 3

Barker's Mill





Apparatus combining all the Mechanical Powers

Bark Mill

Fig. 4

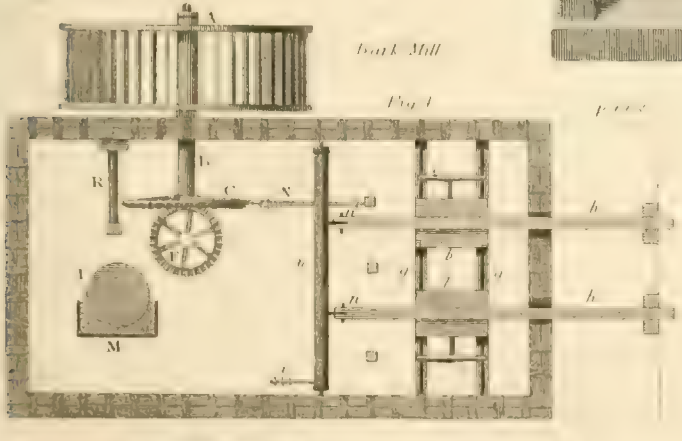


Fig. 5

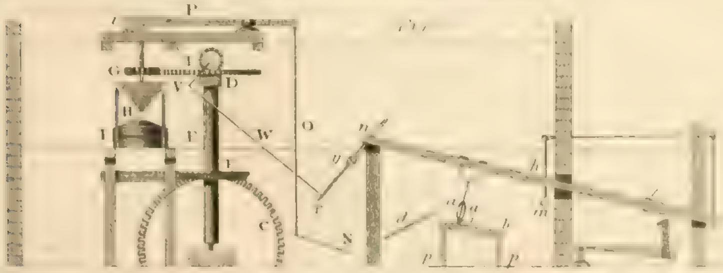
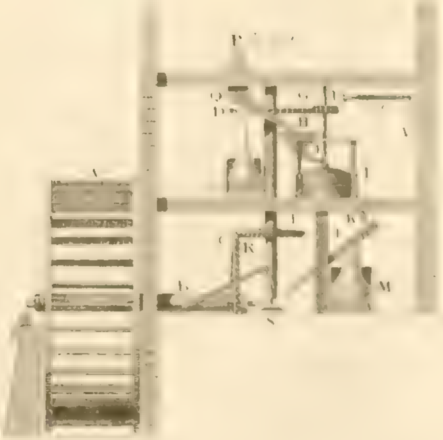


Fig. 6



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stairs raises, together with his own weight, 109 chiliogrammes to one chiliometre;—that a man weighing 150 pounds French, can ascend by stairs three feet French in a second, for the space of 15 or 20 seconds;—that a man cultivating the ground performs $\frac{10}{20}$ as much labour as a man ascending stairs, and that his quantity of action is equal to 328 pounds avoirdupois raised through the space of 3282 feet:—that a man with a winch does $\frac{5}{8}$ as much as by ascending stairs,—and that in a pile engine, a man by means of a rope drawn horizontally, raised for the space of five hours 55¼ pounds French through one foot French in a second. When men walk on a horizontal road, Coulomb found that the quantity of action was a maximum when they were loaded, and that this maximum quantity of action is to that which is exerted by a man loaded with 190·25 pounds avoirdupois as 7 to 4.—The weight which a man ought to carry, in order that the useful effect may be a maximum, is 165·3 pounds avoirdupois. When the workman, however, returns unloaded for a new burden, he must carry 200·7 pounds avoirdupois.

According to Dr. Robinson, a feeble old man raised seven cubic feet of water = 437·5pounds avoirdupois, 11½ feet high in one minute, for eight or ten hours a day, by walking backwards and forwards on a lever; and a young man weighing 135 pounds, and carrying 30 pounds, raised 9¼ cubic feet of water = 578 1 pounds avoirdupois, 11½ feet high, for 10 hours a day, without being fatigued.

From the experiments of Mr. Buchanan, it appears that the forces exerted by a man pumping, acting at a winch, ringing, and rowing, are as the numbers 17·42, 2856, 3883, 4095.

According to Desaguliers and Smeaton, the power of one horse is equal to the power of five men. Several French authors suppose a horse equal to seven men, while M. Schulze considers one horse as equivalent to 14 men.—Two horses, according to the experiment of Amontons, exerted a force of 150 pounds French, when yoked in a plough. According to Desaguliers, a horse is capable of drawing, with a force of 200 pounds, two miles and a half an hour, and of continuing this action eight hours in the day. When the force is 240 pounds he can work only six hours. It appears from Smeaton's reports, that by means of pumps a horse can raise 250 hogsheads of water, 10 feet high, in an hour.—The most disadvantageous way of employing the power of a horse is to make him carry a load up an inclined plane, for it was observed by De la Hire, that three men, with 100 pounds each, will go faster up the inclined plane than a horse with 300 pounds. When the horse walks on a good road, and is loaded with about two hundred weight, he may easily travel 25 miles in the space of seven or eight hours.

When a horse is employed in raising coals by means of a wheel and axle, and moves at the rate of about two miles an hour, Mr. Fenwick found that he could continue at work 12 hours each day, two and a half of which were spent in short intervals of rest, when he raised a load of 1000 pounds avoirdupois, with a velocity of 13 feet per minute;—and that he will exert a force of 75 pounds for nine hours and a half, when moving with the same velocity. Mr. Fenwick also found that 230 ale gallons of water delivered every minute on an overshot water-wheel 10 feet in diameter; that a common steam engine, with a cylinder eight inches in diameter, and an improved engine with a cylinder 6·12 inches in diameter, will do the work of one horse, that is, will raise a weight of 1000 pounds avoirdupois, through the height of 13 feet in a minute. It appears from Mr. Smeaton's experiments, that Dutch sails in their common position with a radius of 9 feet and a half, that Dutch sails in their best position with a radius of eight feet, and that his enlarged sails with a radius of seven feet, perform the same work as one man; or perform one-fifth part of the work done by a horse.

Before concluding, we must revert to a circumstance which we have already noticed briefly, respecting the most efficient mode of employing the power of that useful, but very much abused animal, the horse. That the line of draught is often in a direction injurious to the horse, and tending to diminish his power as a mover of mechanism, will be evident to any person who considers the form of his shoulders. At the place where the neck rises from the chest, (see fig. 9, plate 4,) the shoulder blades form the resting place of his collar or harness into a slope, *a p*. This slope or inclination forms an angle with a perpendicular to the horizon, of about fourteen or fifteen degrees; and therefore the line of traction or draught should form the same angle with the horizon, because he will then pull perpendicularly to the shape of his shoulder, and all parts of that shoulder will be equally pressed by the collar. Besides, in overcoming obstacles, the advantage of this inclined direction is *mechanically* great. Call *a*, fig. 10, plate IV. a wheel, *b* an obstacle, *c* the axle of the wheel, *d* the spoke which sustains the weight. A line drawn from the nearest part of the horizontal line of draught *c k*, to the fulcrum or obstacle at *e*, will form the acting part of a lever *g e*; and another line *e d*, being drawn from the fulcrum *e* to the nearest part of the spoke *d*, will form the resisting part of the same lever. Now, as the acting and resisting arms of the lever are of equal lengths, the lever becomes a scale-beam, and draught in the line *g k* must be equal to the weight of the wheel and all that it sustains, besides the friction; for if *g e d* be a crooked lever, a pull at *g* must be equal to all the weight supported by *d*. But when a horse draws agreeably to the shape of his shoulders in the line *c k*, the acting part of the lever *h e* is lengthened nearly one-fourth; so that if it would require a pull at *g* equal to four hundred weight, a power applied at *h* will draw the wheel over the obstacle *b* with three hundred weight. To those unacquainted with the principles of mechanics, this truth may be easily proved by an ordinary scale-beam. The horse himself, considered as a lever, has in this inclined draught a manifest advantage over his obstacles, in comparison of a horizontal draught, as may be seen by fig. 9. When the horse is yoked to a post, or has any great obstacle to overcome, he converts himself into a lever, making his hind feet the fulcrum, and the centre of gravity of his body to lean over it, at as great a distance as possible, by thrusting out his hind feet; by this means, acting both by his weight and muscular strength, and lengthening the acting part of the lever *a b*, he overcomes the difficulty more by his weight than by his muscular strength, for the muscles of the fore legs act upon the bones to so great a mechanical disadvantage, that though he exerts them with all his might, they serve, in great efforts, for little more than props to the fore part of his body. Hence we see the great use of heavy horses for draught. But the great mechanical use and advantage of the inclined line of draught may be more particularly seen, by calling the line *a b*, fig. 9, the acting part of the lever and the nearest approach from the fulcrum *b* to the inclined line of draught, (that is, *b c*) the resisting part of the lever: compare this with the resisting part of a lever touching the horizontal line of draught, (that is, *b d*,) and it will be found nearly double; in consequence, agreeably to the known properties of the lever, a weight at *g* would require double the exertion in the horse to remove it, that the same weight would require were it placed at *e*. Hence it is evident, that in economizing animal strength, single-horse carts are preferable to teams, because in a team, all but the shaft horse must draw horizontally, and consequently in a manner inconsistent with their structure, and the established laws of mechanics.

On the Teeth of Wheels.—When one wheel impels another, the impelling power will sometimes act with greater and sometimes with less force, unless the teeth of one or both of the wheels be parts of a curve generated after the manner of an epicycloid, by the revolution of one circle along the convex or concave side of the other. When one wheel so impels another, then their motion is uniform. To illustrate this, and shew the application of the cycloid and epicycloid, to give form to the teeth of wheels, let a circle B, proceed in a straight line on the plane C D, fig. 11, plate III. and at the same time revolve round its centre, till every part of the circumference has touched the plane, a point or pencil at *a*, which was lowest at the commencement of the motion, will have described the curve C E D, which is called a *cycloid*, and is evidently compounded of a rectilinear and circular motion.

If a circle A, fig. 12, roll from *o* to *q*, on the convex circumference of another circle B, the point *o* will describe the curve *o p q*, which is called an *exterior epicycloid*; and if the circle A were to roll on the concave circumference of the circle B, as from *r* to *s*, the point *r* would describe an *interior epicycloid*

In all these cases, the circle by which the curve is obtained, is called the generating circle; and one wheel will not drive another with uniform velocity, unless the teeth of one or more of the wheels have their acting surfaces formed into a curve generated after the manner of an epicycloid. But it is not absolutely necessary that the teeth of one or both wheels be exactly epicycloids; for if the teeth of one of them be either circular or triangular, with plain sides, or like a triangle with its sides converging to the centre of the wheel, or of any other form, uniformity of force and motion will be attained, if the teeth of the other wheel have a figure which is compounded of that of an epicycloid and the figure of the teeth of the first wheel. From a variety of cases, we select such forms for the teeth as are best adapted to practice. There are three different ways in which the teeth of wheels may act upon one another; and each mode of action requires a different form for the teeth:—

1st. When the teeth of the wheel begin to act upon the leaves of the pinion just as they arrive at the line of centres; and their mutual action is carried on after they have passed this line. 2d. When the teeth of the wheel begin to act upon the leaves of the pinion before they arrive at the line of centres, and conduct them either to this line, or a very little beyond it. 3rd. When the teeth of the wheel begin to act upon the leaves of the pinion before they arrive at the line of centres, and continue to act after they have passed that line.

For the first, the acting faces of the leaves of the pinion should be parts of an interior epicycloid, generated by a circle of any diameter rolling upon the concave superficies of the pinion; and the acting surfaces of the teeth of the wheel should be portions of an exterior epicycloid, formed by the same generating circle rolling upon the convex superficies of the wheel. Now, it is demonstrable, that when one circle rolls within another whose diameter is double that of the rolling circle, the line generated by any point of the latter will be a straight line tending to the centre of the larger circle. If the generating circle, therefore, mentioned above, should be taken with its diameter equal to the radius of the pinion, and be made to roll upon the concave superficies of the pinion, it will generate a straight line tending to the pinion's centre, which will be the form of the acting faces of its leaves; and the teeth of the wheel will in this case be exterior epicycloids, formed by a generating circle, whose diameter is equal to the radius of the pinion, rolling upon the convex superficies of the wheel. This construction of the teeth of the wheel, and leaves of the pinion, is represented by fig. 13, plate III.; it is strongly recommended by De la Hire and Camus, and is perhaps the most advantageous, as it requires less trouble, and may be executed with greater accuracy, than if the leaves of the pinion had been curved as well as the teeth of the wheel.—The small wheel is the *pinion;* its teeth are called *leaves;* and the line joining their centres, is called the line of centres.

Lanterns or trundles, which consist of cylindrical staves fixed by both ends nearly at the circumferences of two equal circular boards, and which are so frequently substituted by millwrights for pinions, may often be adopted with great propriety, provided the teeth of the wheels working in them have a proper form. The following construction possesses the merit of diminishing the friction arising from the mutual action of the staves and the teeth, and is easily reduced to practice.

Let A, fig. 14, plate III., be the centre of the small wheel or trundle T C H Q, whose teeth are circular like I C R, having their centres in the circle P D E Y. Upon B, the centre of the large wheel, at the distances B C, B D, describe the circles F C K, G D O; and with P D E Y, as a generating circle, form the exterior epicycloid D N M, by rolling it upon the convex superficies of the circle G D O. The epicycloid D N M thus formed, would have been the proper form for the teeth of the large wheel G D O, had the circular teeth of the small wheel been infinitely small; but as their diameter must be considerable, the teeth of the wheel should have another form. In order to determine their proper figure, divide the epicycloid D N M into a number of equal parts, 1, 2, 3, 4, &c. and let these divisions be as numerous as possible. Then, upon the points 1, 2, 3, &c. as centres, with the distance D C equal to the radius of the circular tooth, describe portions of circles similar to those in the figure; and the curve O P T, which touches these circles, and is parallel to the epicycloid D N M, will be the proper form for the teeth of the large wheel. In order that the teeth may not act upon each other till they reach the line of centres A B, the curve O P should not touch the circular tooth I C R till the point O has arrived at D. The tooth O P, therefore, will commence its action upon the circular tooth at the point I, where it is cut by the circle D R E. On this account, the part I C R of the cylindrical pin being superfluous, may be cut off, and the staves of the trundle will then be segments of circles similar to the shaded part of the figure.

The second mode of the mutual action of wheels and pinions above-mentioned is not so advantageous as the former, and therefore should, if possible, be avoided. It is evident, that when the tooth of the wheel acts upon the leaf of the pinion before they arrive at the line of centres, and quits the leaf when they reach this line, that the tooth works deeper and deeper between the leaves of the pinion the nearer it comes to the line of centres; hence friction arises, because the tooth does not, as before, *roll* upon the leaf, but *slides* upon it; and from the same cause, the pinion soon becomes foul, as the dust which lies upon the acting faces of the wheels is pushed into the hollows between them. One advantage, however, attends this mode; it allows us to make the teeth of the large wheel rectilinear, and thus renders the labour of the mechanic less, and the accuracy of his work greater, than if they had been of a curvilinear form. If the teeth, therefore, of the wheel are made rectilinear, having their surfaces directed to the wheel's centre, the acting surfaces of the leaves must be epicycloids formed by a generating circle, whose diameter is equal to the sum of the radius of the wheel, added to the depth of one of its teeth, rolling upon the circumference of the pinion. But if the teeth of the wheel and the leaves of the pinion are made curvilinear, the acting surfaces of the teeth of the wheel must be portions of an interior epicycloid formed by any generating circle rolling within the concave superficies of the large circle, and the acting surfaces of the pinion's leaves must be portions of an exterior epicycloid, produced by rolling the same generating circle upon the convex circumference of the pinion.

When the teeth of the large wheel are cylindrical spindles, either fixed or moveable upon their axis, an exterior epicycloid must be formed like D N M, in fig. 14, plate III., by a generating circle, whose radius is A C, rolling upon the convex circumference F C K; A C being in this case the diameter of the wheel, and F C K the circumference of the pinion. By means of this epicycloid, a curve O P T must be formed as before described, which will be the proper curvature for the acting surfaces of the leaves of the pinion, when the teeth of the wheel are cylindrical. In determining the relative diameter of the wheel and pinion for this mode of action, the radius of the wheel is reckoned from its centre to the extremity of its teeth, and the radius of the pinion from its centre to the bottom of its leaves.

The third way alluded to above, in which one wheel may drive another, namely, "when the teeth of the wheel begin to act upon the leaves of the pinion, before they arrive at the line of centres, and continue to act after they have passed that line," remains to be considered. It is represented by fig. 1, plate IV., and as it is a combination of the two first modes, it partakes both of their advantages and disadvantages. It is evident from the figure, that the portion *e h* of the tooth acts upon the part *b c* of the leaf till they reach the line of centres A B, and that the part *e d* of the tooth acts upon the portion *b a* of the leaf after they have passed that line. It follows, therefore, that the acting parts *e h* and *b c* must be formed according to the directions given for the first mode of action, and that the remaining parts *e d*, *b a*, must have that curvature which the second mode of action requires; consequently *e h* should be part of an interior epicycloid formed by any generating circle rolling on the concave circumference of the wheel, and the corresponding part *b c* of the leaf should be part of an exterior epicycloid formed by the same generating circle rolling upon *b* E *o*, the convex circumference of the pinion; the remaining part *e d* of the tooth should be a portion of an exterior epicycloid, formed by any generating circle rolling upon

# MECHANICS

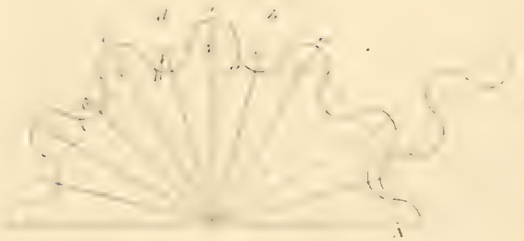
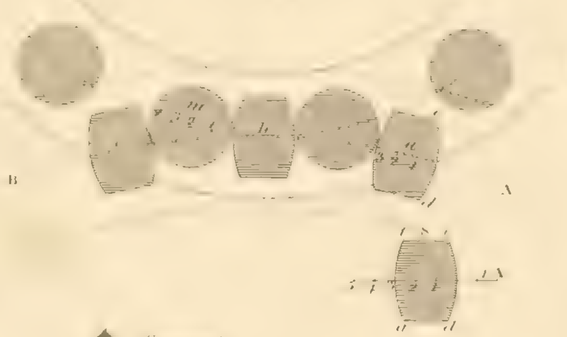


Fig 3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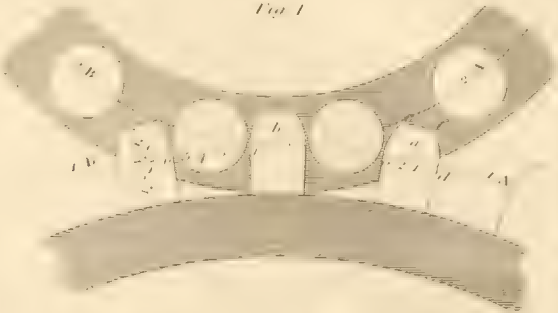
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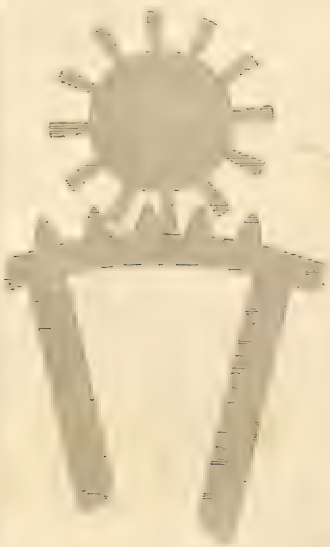
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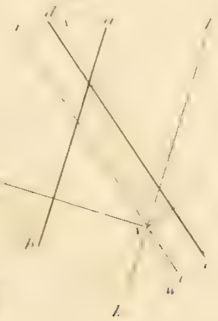


Fig 8

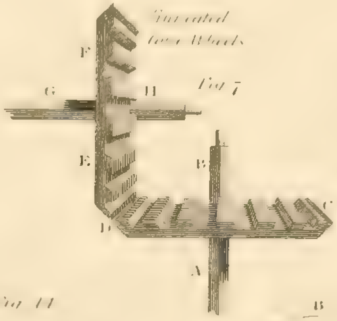


Fig 7

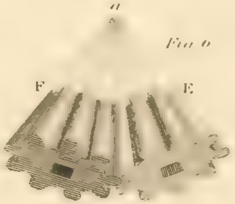


Fig 6

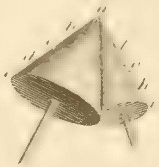
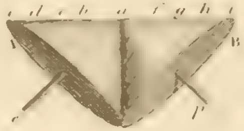


Fig 5.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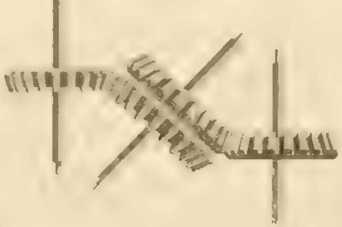
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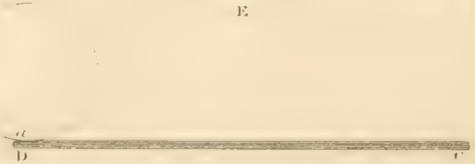


Fig 11

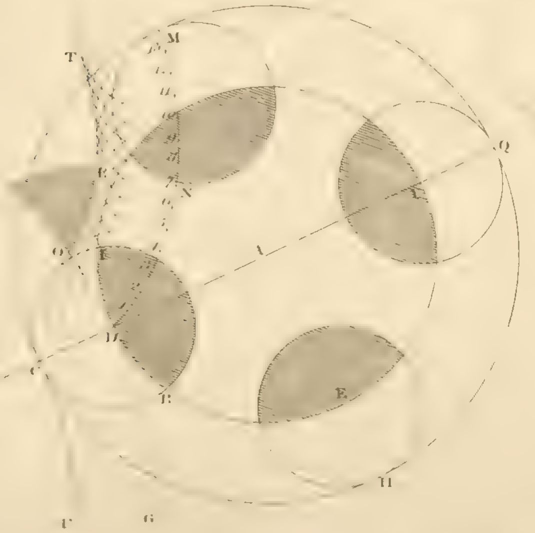


Fig 14

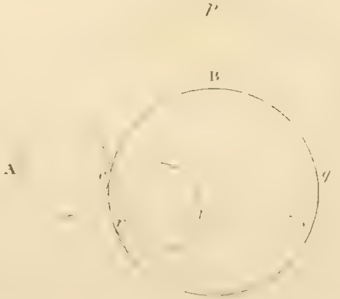


Fig 12.

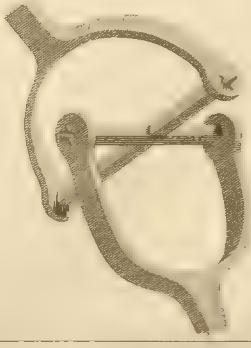
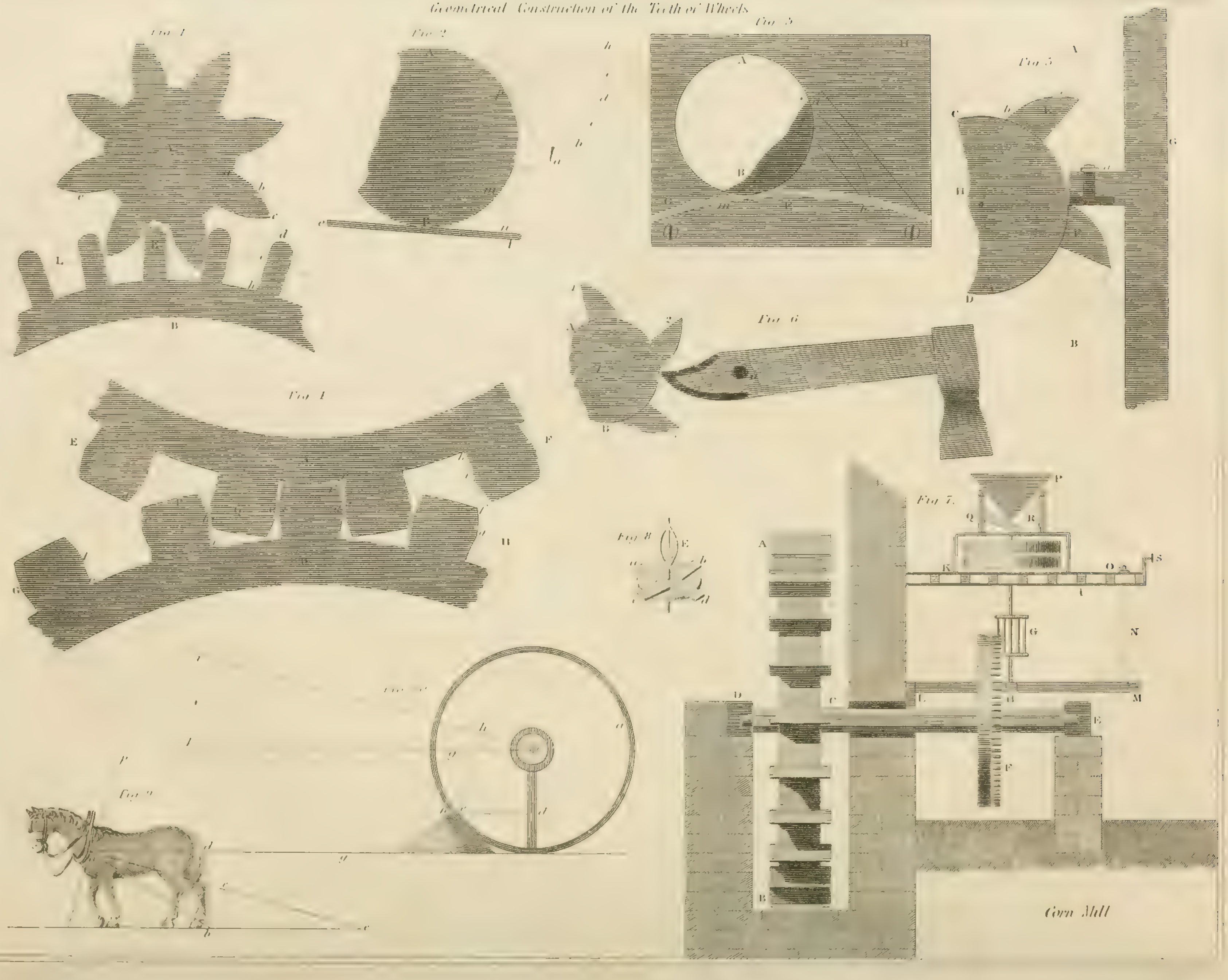


Fig 10

MECHANICS.

Geometrical Construction of the Teeth of Wheels



Published by Henry Fisher, Caxton, London.

$e$ L, the convex superficies of the wheel; and the corresponding part $ba$ of the leaf should be part of an interior epicycloid described by the same generating circle rolling along the concave side $b$ E $o$ of the pinion. But, as in practice, the production of this double curvature of the acting surfaces of the teeth would be exceedingly troublesome to the workman, who would probably never correctly accomplish his object, his labour may be abridged by making $eh$ and $ba$ radial lines, that is, $eh$ a straight line tending to the centre of the wheel B, and $ba$ likewise a straight line tending to the centre A, of the pinion.

The foregoing remarks apply to those cases in which the wheel drives the pinion. When the pinion drives the wheel, the form that has been directed to be given to the teeth of the wheel must be given to the leaves of the pinion, and that assigned to the leaves of the pinion must be given to the wheel.

Another method of forming the teeth, which has had many advocates, consists of making the acting faces of the teeth involutes of the wheel's circumference. Thus let A B, fig. 2, plate IV. be a portion of the wheel on which the tooth is to be fixed, and let A $pm$ be a thread wrapped round its circumference, having a loop-hole at its extremity, $a$. In this loop-hole fix a pin $a$, with which describe the curve or *involute*, $abcdeh$, by unwrapping the thread gradually from the circumference A $pm$. The curve thus obtained will be the proper form for the teeth of a wheel whose diameter is A B. It is a form which admits of several teeth acting together, a circumstance attended with the advantage of diminishing the pressure upon any one tooth, so much as to make the wheels wear longer and more equally; and it possesses the merit of being more easily understood than the other methods directed to be observed. This last mode of forming the teeth of wheels is, however, only a modification of the general principle, and indeed an involute is sometimes reckoned among the exterior epicycloids. The propriety of this will be allowed, when it is considered that the involute $abcd$, &c. may be produced by an epicycloidal motion. Thus let $on$ be a straight ruler, at whose extremity is fixed the pin $n$, and let the point of the pin be placed upon the point $m$ of the circle; then by rolling the straight ruler upon the circular base, so that the point in which it touches the circle may move gradually from $m$ towards B, the curve $mn$ will be generated exactly similar to the involute $abc$, &c. obtained by the string.

Let the mechanic who wishes to have further directions for drawing epicycloids, take a piece of plain wood G H, fig. 3, plate IV., and fix upon it another piece of wood E, having its circumference $mb$ of the same curvature as the circular base upon which the generating circle A B is to roll. When the generating circle is large, the shaded segment B will be sufficient. In any part of the circumference of this segment, fix a sharp pointed steel pin $a$, which ought to be tempered, that it may easily make a distinct mark; and it must be driven in sloping, so that the distance of its point from the centre of the circle may be equally exact to its radius. Fasten to the board G H, a piece of thin brass, or of tin-plate, $ab$. Place the segment B in such a position that the point of the steel pin $a$ may be upon the point $b$, and roll the segment toward G, so that the nail $a$ may rise gradually, and the point of contact between the two circular segments advance towards $m$; the curve $ab$, described upon the brass plate, will be an accurate *exterior* epicycloid. Remove, with a file, the part of the brass on the left hand of the epicycloid, and the remaining concave $ab$ will be a pattern tooth, by means of which all the rest may easily be formed. When an *interior* epicycloid is required, the generating circle must revolve upon a *concave* instead of a *convex* base, as in the present instance. The *cycloid*, which is useful in forming the teeth of *rack-work*, is generated in precisely the same manner, with this difference only, that the base on which the generating circle rolls must be a straight line.

Perhaps no part of the mechanism of mill-work is executed with so little attention to theory as the teeth of wheels. Almost every millwright has his favourite construction, and it is seldom that the best methods are adopted. One of the many plans in ordinary use we shall here recite; from its being of tolerably easy application, and allowing much strength to the teeth, while it is somewhat free from friction in comparison with other practical methods. Let A B, fig. 4. plate IV., be two spur wheels of different diameters, of which the cogs are intended to work into each other at half pitch. The dotted circular arcs G H, E F, touching each other between $s$ and $d$, are the centre or pitch lines, from which the teeth are formed. If the teeth of both wheels are iron, as is generally the case in the first motions of work, those teeth are then made nearly both of a size at the pitch-line; but if the teeth of one be wood and the other iron, then the iron ones are made to have less pitch than the wooden ones, because they are then found to wear better. In the figure both are supposed to be of iron. Suppose the wheels to move from G toward H, and from E towards F, and that the sides of the teeth at $bc$, and $de$, are in contact; from $b$ as a centre, with a radius equal to $bp$, describe the arcs $pd$, $lm$; from $d$ as a centre with the same radius, describe the arcs $hi$, $fg$, $ck$. Thus the same opening of the compasses, and a centre chosen where the wheels are in contact on the pitch lines, will mark the contour of the upper part of a tooth of one wheel, and the lower part of a corresponding tooth of the other wheel; and by taking several centres on the two pitch-lines, the various teeth may be formed. To prevent the cogs from *bottoming*, as the workmen call it, let the lower part, $re$, of one tooth be made rather longer than the upper part $pd$, of the other which is to play into it. The way in which cogs thus constructed will work into one another, may be understood by considering the motion of two of them, $n$ and $o$ for example; when they first come into contact, they will appear as the curve $x$ P $z$; when they arrive at Q, the same sides will appear as in the dotted lines there represented; and when the same arrive at R S, they are in contact on other middle points.

*Of Wipers or Lifting Cogs.*—It may be useful to notice here, that by means of notches called *wipers*, which project from the circumference of a wheel or axle, stampers, hammers, and other tools, are raised vertically and then suffered to fall.

Fig. 5, plate IV., represents portions of a stamper for bruising ore, beating hemp, &c. and of its shaft with lifting cogs. G is the vertical arm of the stamper, sliding, when in actual work, between rollers, or in a groove, to keep it steadily in its proper position; $a$ is the horizontal arm of the stamper; H part of the axle, on which the wipers or lifting cogs E F are fixed; the dotted lines at A, shew the height to which the horizontal arm $a$, of the stamper, is elevated by each wiper. A B is a line corresponding with the arm of the stamper upon which the wipers first act; C D is the pitch-line of the axis, or the bottom of the curves of the wipers. The curved or acting faces of the wipers are involutes of a circle equal in radius to the axis C D, and obtained as already described in noting its application to the formation of the teeth of wheels, viz. by unwrapping from the circumference of the circle alluded to, a thread or cord $b$, in the loop-hole, at the extremity of which is a pencil or marking point, describing the curve as it approaches towards $c$. The arm of the stamper is flat at the part where the wiper acts upon it, and should be placed in a line with the centre of the shaft or axis, at the time the first wiper comes into contact with it.

Fig. 6, plate IV., exhibits the form of the wipers for a forge-hammer. The centre $b$, of the cylinder AB, in which the wipers are fixed, the flat part or tail-end of the hammer, where acted upon by the wipers, and the centre of the axis $a$ of the hammer, must be in the same right line. The proper curve for the wipers is an exterior epicycloid; formed by rolling upon the circumference of the circle at B, a circle of which the radius is equal to the distance from the centre of the axis $a$ to the extremity of the tail of the hammer.

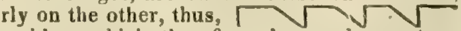
*Description of a common Corn Mill.*—The water wheel A B, fig. 7, plate IV., is generally from eighteen to twenty-four feet in diameter, reckoning from the outermost edge of any float-board at A, to that of the opposite one at B. The water striking on the floats of this wheel, drives it round, and gives motion to the mill. The wheel is fixed upon a very strong axis or shaft C, one end of which rests on D, and the other on E within the mill-house. On the shaft or axis C, and within the mill house, is a wheel F, about eight or nine feet in diameter, having cogs all round, which work in the upright staves or rounds of a trundle G. This trundle is fixed upon a strong iron axis, called the spindle, the lower end of which turns in a brass foot fixed at H, in a horizontal beam H, called the bridge-tree; and the upper end of the spindle turns in a wooden bush fixed into the nether mill-stone, which lies upon beams in the floor I. The top of the spindle above the bush is square, and goes into a square hole in a strong iron cross, *a b c'd*, fig. 8, called the rynd, under which, and close to the bush, is a round piece of thick leather upon the spindle which it turns round at the same time it does the rynd. The rynd is let into grooves in the under surface of the upper or running mill-stone, which it turns round in the same time that the trundle G is turned round by the cog-wheel F. This mill-stone has a large hole quite through its middle, called the eye of the stone, through which the middle part of the rynd and upper end of the spindle may be seen; whilst the four ends of rynd lie below in their grooves.

One end of the bridge-tree H, which supports the spindle, rests upon the wall, and the other end is let into a beam called the brayer, L M. The brayer rests in a mortise at L, and the other end M, hangs by a strong iron rod N, which goes through the floor I, and has a screw and nut on its top at O; by the turning of this nut, the end M of the brayer is raised or depressed at pleasure, and consequently the bridge-tree and the upper mill-stone. By this means the upper mill-stone may be set as close to the under one, or raised as much above it, as may be necessary. It will of course be understood that the nearer the mill-stones are to each other, the finer the corn will be ground; and that, on the contrary, the further they are separated, the coarser it will be.

The upper mill-stone is enclosed in a round box, which no where touches it, and is about an inch distant from its edge all round. On the top of this box stands a frame for holding the hopper P, to which is hung the shoe Q, by two lines fastened to the hinder part of it, fixed upon hooks in the hopper, and by one end of the string R fastened to the fore part of it, the other end being twisted round the pin, S. By turning this pin one way, the string draws up the shoe closer to the hopper, and so lessens the aperture between them: and as the pin is turned the other way, it lets down the shoe, and enlarges the aperture. If the shoe be drawn up quite to the hopper, no corn can fall from the hopper into the mill; if it be let down a little, some will fall; and the quantity will be more or less, according as the shoe is more or less let down; for the hopper is open at the bottom, and there is a hole at the bottom of the shoe, not directly under the bottom of the hopper, but nearer to the lowest end of the shoe, over the middle or eye of the stone.

In a square hole at the top of the spindle, is put the feeder E, fig. 8. This feeder, as the spindle turns round, jogs the shoe three times in each revolution, and so causes the corn to run constantly down from the hopper through the shoe, into the eye of the mill-stone, where it falls upon the top of the rynd, and is, by the motion of the rynd, and the leather under it, thrown below the upper stone, and ground between it and the lower one. The rapid motion of the stone creates a centrifugal tendency in the corn going round with it, by which means it gets farther and farther from the centre, as in a spiral, in every revolution, until it is quite thrown out, and being then ground, it falls through a spout, called the mill-eye, into a trough placed for its reception.—When the mill is fed too fast, the corn bears up the stone, and it is ground too coarse; besides, the mill is apt to get clogged, and to go too slowly. When the corn is scantily supplied, the mill goes too fast, and the stones by their collision are apt to strike fire. Both these inconveniences are avoided, by turning the regulating pin, S, backward or forward, in order to draw up or let down the shoe, as the case is observed by the miller to require.

The heavier the running mill-stone, and the greater the quantity of water falling upon the wheel, the faster will the mill bear to be fed, and consequently the greater the performance of the mill. When the stone is considerably worn, and become light, its weight must either be increased by some artificial addition, or the mill must necessarily be fed slowly; otherwise the stone will be too much borne up by the corn under it, to grind the meal sufficiently fine. The power necessary to turn a heavy mill-stone, is but very little more than what is necessary to turn a light one; for as the stone is supported upon the spindle of the bridge-tree, and the end of the spindle that turns in the brass foot is but small, the difference arising from the weight produces only an inconsiderable action against the power or force of the water. Besides, a heavy stone affords the same advantage as a heavy fly, that is, it regulates the motion much better than a light one, from its not being liable to such great fluctuations of velocity.

In order to cut and grind the corn, both the upper and under mill-stones have channels or furrows cut in them, proceeding obliquely from the centre to the circumference. These furrows, in the direction of their length, are cut slantwise on one side, and perpendicularly on the other, thus,  so that each of the ridges which they form has a sharp edge; and in the two stones, these edges pass one another like the edges of a pair of scissars, and so cut the corn, to make it grind the more easily, when it falls upon the furrows. The furrows are cut the same way in both stones, when they lie upon their backs, which makes them run crosswise to each other when the upper stone is inverted by turning its furrowed surface towards that of the lower, for, if the furrows of both stones lay the same way, part of the corn would be driven onward in the lower furrows, and come out from between the stones without being either ground or bruised. The grinding surface of the under stone is a little convex from the edge to the centre, and that of the upper stone a little concave; and they are farthest from one another in the middle, but approach gradually nearer towards the edges. By this means the corn, at its first entrance between the stones, is only bruised; but as it goes farther on towards the circumference or edge, it is cut smaller and smaller, and at last finely ground, just before it comes out from between them.

When the ridges become blunt and the furrows shallow by wearing, the running stone must be taken up, and both of them may then be dressed anew with a chisel and mallet. Every time the stone is taken up, there must be some tallow put round the spindle and upon the bush; this unguent will soon be melted by the heat the spindle acquires from its turning and rubbing against the bush, which it will prevent from taking fire.

The bush must embrace the spindle quite close, to prevent any shake in the motion, which would cause some parts of the stones to grate against each other, whilst the other parts of them would be too far asunder, and by that means spoil the meal. Hence, whenever the spindle has worn the bush, so as to begin to shake in it, the stone must be taken up, and a chisel driven into several parts of the bush; and when it is taken out, wooden wedges must be forced into the holes; by which means the bush will be made closely to embrace the spindle again all round. In doing this, great care must be taken to drive equal wedges into the bush on opposite sides of the spindle: otherwise it will be thrown out of the perpendicular, and so hinder the upper stone from being set parallel to the under one, which is absolutely necessary for making good work. When any accident of this kind occurs, the perpendicular position of the spindle must be restored, by adjusting the bridge-tree with proper wedges put between it and the brayer.

The rynd is sometimes wrenched in laying down the upper stone upon it, or is made to sink a little lower on one side of the spindle than on the other; and this will cause one edge of the upper stone to drag all round upon the lower, while the opposite edge will not touch. This is easily rectified, by raising the stone a little with a lever, and putting bits of paper, card, or thin chips, between the rynd and the stone.

Till the steam-engine came into general use, so as to make people independent of water and wind, and animal strength, as agents to drive machinery, the first-named was considered the best moving power; and wind the next, where water was denied; and they are still used as valuable and powerful movers in many situations. To illustrate the combinations of machinery, any of these might be taken. We shall, for this purpose, confine ourselves at present to

*Water Mills.* There are three descriptions of these, namely, Breast-mills, Undershot-mills, and Overshot-mills, according to the manner in which the water is applied to the great wheel. In the first, the water falls down upon the wheel at right angles to the float-boards or buckets placed all round the wheel to receive it. In the second, which is used where there is no fall but a considerable body of water, the stream strikes the float-boards at the lower part of the wheel. In the third, the water is poured over the top, and is received in buckets formed all round the wheel. According to Smeaton, the power necessary to produce the same effect on the undershot-wheel, a breast-wheel, and an overshot wheel, must be to each other as the numbers 2·4, 1·75, and 1.

Rules for the Construction of Water-Mills:—1. Measure the perpendicular height of the fall of water, in feet, above that part of the wheel on which the water begins to act, and call that the height of the fall. 2. Multiply this constant number 64·2822 by the height of the fall in feet, and the square root of the product will be the velocity of the water at the bottom of the fall, or the number of feet that the water there moves per second. 3. Divide the velocity of the water by three, and the quotient will be the velocity of the float-boards of the wheel, or the number of feet they must each go through in a second, when the water acts upon them so as to have the greatest power to turn the mill. 4. Divide the circumference of the wheel in feet by the velocity of its floats in feet per second, and the quotient will be the number of seconds in which the wheel turns round. 5. By this last number of seconds divide 60, and the quotient will be the number of turns of the wheel in a minute. 6. Divide 120 (the number of revolutions a millstone four feet and a half in diameter ought to have in a minute) by the number of turns of the wheel in a minute, and the quotient will be the number of turns the millstone ought to have, for one turn of the wheel. 7. Then, as the number of turns of the wheel in a minute is to the number of turns of the millstone in a minute, so must the number of staves in the trundle be to the number of cogs in the wheel, in the nearest whole numbers that can be found.

The breadth of the water-wheel ought to correspond with the power necessary on the occasion, supposing that a proportionate volume of water is at command; for a wheel of two feet in breadth will be more than double as powerful as one only a foot broad, there being a double volume of water acting upon it, while the friction of the axis is by no means doubled with this augmentation of breadth.

It may be well to notice here Smeaton's discovery, that "the more slowly any body descends by the force of gravity while acting upon any piece of machinery, the more of that force will be spent upon it, and consequently the effect will be the greater." That effect is not increased in proportion to the velocity of the wheel's motion. Smeaton found, that when the wheel with which he experimented (two feet in diameter) revolved 20 times in a minute, its effect was greatest; when it made only 18½ turns, the effect was irregular; and when so laden as not to make 18 turns, the wheel was overpowered by the load: thirty turns in the minute occasioned a loss of about one-twentieth; and when turned above 30 times in a minute, the diminution of effect was nearly one-fourth of its powers. This proportion may be easily estimated on any wheel of greater extent, by computing the proportion of accumulated power lost by greater velocity than may be sufficient to load the wheel by means of the buckets being filled; observing, that the progress of a machine may be so much retarded as to cause the effect to be irrelevant to the purpose, although the machine may be kept in motion.

To compute the effects of water-wheels, ascertain, 1. The real velocity of the water which acts upon the wheel; 2. the quantity of water expended in a given time; and 3. how much of the power is lost by friction. Smeaton found that the mean power of a volume of water 15 inches in height, gave 8·96 feet of velocity in each minute to a wheel on which it impinged. The computation of the power to produce such an effect, allowing the head of water to be 105·8 inches, gave 264·7 pounds of water descending in one minute through the space of 15 inches, therefore 264·7, multiplied by 15, was equal to 3·970. But as that power will raise no more than 9·375 pounds to the height of 135 inches, it was manifest that the major part of the power was lost; for the multiplication of these two sums only amounted to 1·266; of course the friction was equal to three-fourths of the power. According to Smeaton, this is the maximum single effect of water upon an undershot-wheel, where the fall is fifteen inches. The remainder of power, it is plain, must equal that of the velocity of the wheel itself, multiplied into the weight of the water, which in this case brings the true proportion between the power and the effect to be as 3·849 to 1·266, or as 11 to 4.

In Undershot mills, the float-boards should be rather numerous than few. Smeaton found when he reduced them from 24 to 12, that the effect was reduced one-half, because the water escaped between the floats without touching them; but when he added a circular sweep of such length, that before one float board quitted it, another had entered it, he found the former effect nearly restored. This mode more particularly applies to breast wheels, or such as receive the water immediately below the level of the axis. In such, the float boards should be confined both at their sides and at their extremities, so that the water may accompany them all the way from the head down to the lowest part of the wheel, whence it should pass off with sufficient readiness to allow the succeeding fall to supply its place, without being in the least retarded. It has been ascertained, that a very sensible advantage is gained by inclining the float-boards to the radius of the wheel, so that each float-board, when lowest, shall have its edge turned up the stream about twenty degrees.

The Overshot wheel is the most powerful, giving a result equal to four-fifths of the power.

The Breast wheel, well constructed, yields a half or 3-5ths of the power. But often, from inattention to the reduction of friction, and inaccurate workmanship, the power not only of this, but of the preceding forms also, is greatly reduced.

The teeth of wheels ought not to act upon each other before they arrive at the line which joins their centres; and though the inner or under side of the teeth may be of any form, yet it is better to make both sides alike, that the wheels may admit of being revolved either way with equal facility. The teeth should be made as fine as the case admits, so that the greatest number possible may be in contact at once; and the utmost care should be taken to have them so regularly disposed that they may not interfere with each other before they begin to work; and they should be so formed that the pressure by which one of them urges the other round its axis, may be constantly the same. This is by no means the case, when the common construction of a spur wheel, acting in the cylindrical staves of a lantern or trundle, is used. The ends of teeth should never be formed of parts of circles, unless working with other teeth, specifically adapted to them.

*Method of Setting out Wheels.*—For a Spur-wheel and Trundle, Lantern or Wallower, draw the pitch lines A 1, B 1, A 2, B 2, fig. 1, plate III., then divide the number of teeth or cogs required, as *a b c*. Divide one of these distances, as *b c*, into 7 equal parts, as 1, 2, 3, 4, 5, 6, 7: allow 3 for the thickness of the cogs, as 1, 2, 3, in the cog *a*; and 4 for the diameter of the stave of the trundle, as 1, 2, 3, 4, in the stave *m*, fig. 2. Three parts are allowed for the cog, and 4 for the stave, the wallower being supposed to be of less diameter than the wheel, therefore subject to more wear, in proportion as the number of cogs exceed the number of staves; but if in any case the number of staves and cogs be the same, they may be of equal thickness. The height of the cog is equal to 4 parts; then divide its height into 5 equal parts, as 1, 2, 3, 4, 5 in the cog *c*; allow 3 for the bottom to the pitch line of the cog; the other 2 for the curve which must be given it, to make it fit and bear on the stave equally.

In common practice, the millwrights are accustomed to put the point of a pair of compasses in the dot 3 of the cog *a*, and strike the line *d f*; then they remove the point of the compasses to the point *d*, and strike the curve 3 *e*, by which means they obtain a curve which they consider sufficiently correct.

For a face-wheel, divide the pitch-line A B, fig. 2, into the number of cogs intended, as *a b c*; divide the distance *b c* into 7 equal parts; allow 3 of these for the thickness of the cogs, as 1, 2, 3, in the cog *a*, 4 for the height, and 4 for the width, as *d e*, and 4 for the thickness of the stave *m*. Draw a line through the centre of the cog, as the line A 1, at S; and on the point 5 describe the line *d e*; remove the compasses to the point A, and draw the line *f g*, by which the shape of the cog will be determined.

For common spur nuts, divide the pitch-line, A, fig. 3, into twice as many equal parts as there are intended to be teeth, as *a*, *b*, *c*, *d*, *e*; with a pair of compasses open to half the distance of any of these divisions, from the points *a* 1, *c* 3, *e* 5, draw the semicircles *a*, *c*, and *e*, which will form the ends of the teeth. From the points 2, 4, and 6, draw the semicircles $g$, $h$, $i$, which will form the lower parts of the spaces. Though spur-nuts are usually set out in this manner, yet in good work, the ends of the teeth must not be semicircles, unless working with other teeth adapted to them, but epicycloids.

*Of Bevel Geer.*—Bevelled wheels, commonly called bevel-geer, which have nearly superseded the spur wheels and trundles, are, in effect, truncated cones, rolling on the surface of each other. Suppose the cones A and B, revolving on their centres $ap$, $ac$, fig. 4, plate III.; if their bases are equal, they will perform their revolutions in equal times, and consequently any two points equally distant from the centre $a$ of A, as $ab$, $ac$, $ad$, $ae$, will revolve in the same time as $af$, $ag$, $ah$, $ai$. If one of the cones, as in fig. 5, be twice the diameter of the other, the base of the larger will make one revolution, while that of the smaller will make two; and all the corresponding parts of the conical surfaces will observe the same proportion; that is, $ab$, $ac$, $ad$, $ae$, will turn only once round, while $af$, $ag$, $ah$, $ai$, turn twice round; the number of the revolutions of all cones revolving in this manner, being to each other as their respective diameters. Let two cones have teeth cut in them, as represented by fig. 6; they will become bevel-geer. These teeth would be broadest at the base, from whence they would gradually taper with the lessening circumference of the cone, till they terminated at the apex $a$ in a point; but as such an extent of teeth would be unnecessary, the useless parts of the teeth are cut off, as at E and F; that is, bevel-geer is composed of wheels made in the form of truncated cones, as shewn by fig. 7, where the upright shaft A B, with the bevel-wheel C D, turns the bevel-wheel E F, with its shaft G H, and the teeth work freely in each other.

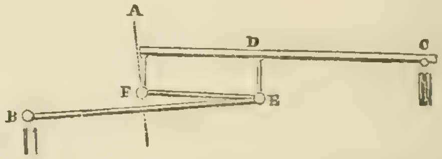
The method of conveying motion in any direction, and of proportioning or shaping the wheels accordingly, is as follows: let the line $ab$, fig. 8, plate III. represent the shaft coming from a wheel; draw the line $cd$ to intersect the line $ab$ in the direction intended for the motion to be conveyed, and this line $cd$ will represent the shaft of the bevel-wheel which is to receive the motion. Suppose then the shaft $cd$ is to revolve three times, whilst the shaft $ab$ revolves once; draw the parallel line $ii$ at any moderate distance, (suppose one foot by a scale,) then draw the parallel line $kk$, at three feet distance, after which draw the dotted line $wx$, through the intersection of the shaft $ab$ and $cd$, and likewise through the intersection of the parallel lines $ii$ and $kk$, in the points $x$ and $y$, which will be the pitch-line of the two bevel-wheels, or the line where the teeth of the two wheels act on each other, as may be seen by fig. 9, where it is obvious to inspection that the motion may be conveyed in any direction.

In crown wheels and bevelled geer, the faces of the teeth must be all tapered, as if they proceeded from a common centre. The pinion may be considered as a portion of a cone, which, rolling along the horizontal rim of the wheel, traces the contour of the teeth, by describing a modified epicycloid. The same general principles indicate all the variations. It is of practical consequence that the teeth of wheels should all be equally worn. In their mutual congress, therefore, they ought to produce a series of the most diversified contacts. To effect this object, the number of teeth in the pinion and the wheel must be as discordant as possible. If the one were any aliquot part of the other, the same incessant coincidence would soon recur, occasioning a partial and disproportionate attrition. Prime numbers should be preferred, and the larger they are, the smoother will the wheels work. The odd tooth in the pinion is by our mill-wrights very appositely called the *hunting cog*.

The effects produced by machines are extremely diversified. To extend action to a distance, or to divert its direction, to reduce or multiply the celerity impressed; to modify an uniform progression into an accelerating or retarding one; to maintain a parallel motion; to change a rectilineal into a circular motion, and the reverse; to convert a reciprocating play into a constant circulation or equable rectilineal flow;—these are a few of the objects generally aimed at. Pressure is conveyed to any distance, by a system of parallel levers, supported at certain intervals, the extremities of their arms being connected by a train of beams. The direction of any power is easily changed, by means of a crank or bent lever. The same contrivance, aided by the action of a fly, converts a reciprocating into a circular motion. This effect is likewise produced by a rack, working alternately on the opposite sides of a toothed wheel. The celerity is modified at pleasure, by affixing to the axle solid blocks, sometimes called *heart wheels*, and fashioned like spiral or eccentric curves. These lines may be traced with such accuracy as to evolve the precise succession of impulse required. But all the transitions should, if possible, be gradual, any sudden change occasioning a concussion which wastes the force, and tends to disjoint and shatter the parts of the machine.

The most elegant mode of transmitting force in any direction, is by a contrivance termed the *Universal Joint*, (see the Plate, fig. 10.) Instead of the cross, a ring or a ball is often preferred. But the angular motion communicated in this way is not quite equable, and becomes even irregular in the case of great obliquity. By doubling, however, the combination of axes, the impression may be turned aside almost into an opposite direction, and may be rendered uniform by a compensation of irregularities.

An alternate motion is beautifully converted into a revolving one, by a vertical rod which carries affixed to it a wheel indented to another wheel of the same size. The central wheel, describing at each reciprocation a double circumference, must turn twice round. This mechanism is, from a vague analogy, called the *Sun and Planet Wheel.* A reciprocating beam can be made to raise and depress a rod very nearly in a vertical line, by means of a regulated parallelogram. Thus, as in the figure, C being the centre of the beam, let an arm B E turn about the firm joint B, and guide the end E of the parallelogram A D E F; if C D be taken a mean proportional to A D and B E, the other end F, carrying the rod of a piston, will travel in a path which is very nearly rectilineal and perpendicular. These two fine contrivances were happily combined in Watt's Steam Engine.



**Mechanical** *Surgery*, is a branch of the profession, the object of which is, by mechanical means, to relieve or to remedy certain deformities or injuries to which some persons are subject from their birth, but which in many cases are the result of accident.

**MEDAL** denotes a piece of metal in the form of coin, such as was either current money among the ancients, or struck on any particular occasion, to preserve the portrait of some great person, or the memory of some illustrious action, to posterity. As historical documents, they form the principal evidence we can have of the truth of the old historians. In some few instances they correct the names of sovereigns; and in a great many, illustrate the chronology of reigns. By their assistance the geographer has sometimes been enabled to determine the situation of a town whose name alone has reached us. To the naturalist they afford the only proofs of the knowledge which the ancients had of certain plants and animals; and they sometimes preserve delineations of buildings for the architect, of which not even a ruin is at this day standing.

**MEDALLION**, or **Medalion**, a medal of an extraordinary size, supposed to be anciently struck by the emperors for their friends, and for foreign princes and ambassadors. But, that the smallness of their number might not endanger the loss of the devices they bore, the Romans generally took care to stamp the subject of them upon their ordinary coin. Medallions, in respect of the other coins, were the same as modern medals in respect of modern money: they were exempted from all commerce, and had no other value than what was set upon them by the fancy of the owner. Medallions are so scarce, that there cannot be any set made of them, even though the metals and sizes should be mixed promiscuously.

**MEDEOLA**, *Climbing African Asparagus*, a genus of plants belonging to the hexandria class, and in the natural method ranking under the 11th order, sarmentaceæ.

MEDIANA, the name of a vein or little vessel, made by the union of the cephalic and basilic in the bend of the elbow.

MEDIASTINUM, in Anatomy, a double membrane, formed by a duplicature of the pleura; serving to divide the thorax and the lungs into two parts, and to sustain the viscera, and prevent their falling from one side of the thorax to the other. *See* ANATOMY.

MEDIATE, or INTERMEDIATE, something that stands betwixt and connects two or more terms considered as extremes; in which sense it stands opposed to *immediate*.

MEDIATOR, a person that manages or transacts between two parties at variance, in order to reconcile them. The word, in scripture, is applied, 1. To Jesus Christ, who is the only intercessor and peace-maker between God and man, (1 Tim. ii. 5.) 2. To Moses, who interposed between the Lord and his people, to declare unto them his word, (Deut. v. 5. iii. 19.)

MEDICAGO FALCATA. *Yellow Medic.*—Is nearly allied to lucerne, and is equally good for fodder; it will grow on land that is very dry, and hence is likely to become a most useful plant; its culture has, however, been tried but partially. Some experiments were made with this plant by Thomas Le Blanc, Esq., in Suffolk, which are recorded by Professor Martyn.

MEDICAGO POLYMORPHA. *Variable Medic.*—This is also a plant much relished by cattle, but is not in cultivation: it is an annual, and perhaps inferior in many respects to the Nonsuch, which it in some measure resembles. There are many varieties of this plant cultivated in flower gardens on account of the curious shapes of the seed-pods, some having a distant resemblance to snails' horns, caterpillars, &c. under which names they are sold in the seed-shops. It grows in sandy hilly soils; the wild kind has flat pods.

MEDICAGO SATIVA. *Lucerne.*—Too much cannot be said in praise of this most useful perennial plant: it is every thing the farmer can wish for, excepting that it will not grow without proper culture. It should be drilled at eighteen inches distance, and kept constantly hoed all summer, have a large coat of manure in winter, and be dug into the ground between the drills. Six or seven pounds of seed will sow an acre in this mode. Lucerne is sometimes sown with grass and clover for forming meadow land; but as it does not thrive well when encumbered with other plants, no good can be derived from the practice. No plant requires, or in fact deserves, better cultivation than this, and few plants yield less if badly managed.

MEDICAGO LUPULINA. *Trefoil*, or *Nonsuch.*—A biennial plant, very usefully cultivated with rye-grass and clover for forming artificial meadows. Trefoil when left on the ground will seed, and these will readily grow and renew the plant successively; which has caused some persons to suppose it to be perennial. About eight or ten pounds of seed are usually sown with six or eight pecks of rye-grass for an acre, under a crop of barley or oats.

MEDICAGO, *Snail Trefoil*, a genus of plants belonging to the diadelphia class, and in the natural method ranking under the 32d order, papilionaceæ. See *Green's Botanical Dictionary*. For the properties and culture of *Lucerne*, a species of this genus, see AGRICULTURE.

MEDICINAL, any thing belonging to medicine.

MEDICINAL *Springs*, a general name for any fountain, the waters of which are of use for removing certain disorders. They are commonly either chalybeate or sulphureous. *See* SPRINGS and WATER.

MEDICINE, the art of preventing, curing, or alleviating those diseases to which the human body is subject, is of very great antiquity, for we find that the sacred historian styles those servants to Joseph, who embalmed the body of the patriarch Jacob, "physicians." Joseph was then in Egypt, the cradle of science, where *Hioth*, the inventor of the art, shared divine honours with Osiris and Isis. Esculapius was the most eminent practitioner among the Greeks, and the writings of Hippocrates are the most ancient on this art, since they were penned 400 years before Christ. This sage judged of diseases from the look, posture of the patient in bed, from respiration, the excrementitious discharges, expectoration, sweat, and the pulse. His maxims for the preservation of health are, temperance, exercise, and labour. His maxims for the cure of diseases are, that evacuations cure those diseases which come from repletion, and repletion those caused by evacuations. The first physician of eminence who differed considerably in his practice from Hippocrates was Praxagoras. Cœlius Aurelianus acquaints us, that he made great use of vomits in his practice, insomuch as to exhibit them in the iliac passion till the excrements were discharged by the mouth. In this distemper he also advised, when all other methods failed, to open the belly, cut the intestine, take out the indurated fæces, and then to sew up all again; but this practice has not probably been followed by any subsequent physician. This man had for a disciple the famous Herophilus, who was contemporary with Erasistratus, a physician of great eminence, who flourished in the time of Seleucus, one of the successors of Alexander the Great.

Celsus, who lived in the time of Tiberius, ranks next to Hippocrates as a medical writer and physician. Galen, a native of Pergamus, made a great figure as a writer and practitioner in this art during the reign of Adrian. Time would fail us to name all the useful and empiric physicians who flourished from that period till the downfall of the Roman empire, when the inundation of Goths and Vandals had almost completely exterminated literature of every kind in Europe, and medicine, though a practical art, shared the same fate with more abstract sciences. Learning in general, banished from the seat of arms, took refuge among the eastern nations, where the arts of peace still continued to be cultivated. To the Arabian physicians, as they have been called, we are indebted both for the preservation of medical science, as it subsisted among the Greeks and Romans, and likewise for the description of some new diseases, particularly the small pox. Among the most eminent of the Arabians, we may mention Rhases, Avicenna, Albucasis, and Avenzoar. But of their writings it would be tedious, and is unnecessary, to give any particular account. They were for the most part, indeed, only copiers of the Greeks. We are, however, indebted to them for some improvements. They were the first who introduced chemical remedies, though of these they used but few, nor did they make any considerable progress in the chemical art. Anatomy was not in the least improved by them, nor did surgery receive any advancement till the time of Albucasis, who lived probably in the 12th century. They added a great deal to botany and the materia medica, by the introduction of new drugs, of the aromatic kind especially, from the East, many of which are of considerable use. They also found out the way of making sugar; and by help of that, syrups; which two new materials are of great use in mixing up compound medicines.

In the beginning of the 16th century, the famous chemist Paracelsus introduced a new system into medicine, founded on the principles of chemistry. The Galenical system had prevailed till his time; but the practice had greatly degenerated, and was become quite trifling and frivolous. The physicians in general rejected the use of opium, mercury, and other efficacious remedies. Paracelsus, who made use of them, had therefore greatly the advantage over them; and now all things relating to medicine were explained on imaginary chemical principles. It will easily be conceived, that a practice founded in this manner could be no other than the most dangerous quackery. The discovery of the circulation of the blood in the year 1528, opened a new era in medicine, which the abilities of Stahl, Hoffman, Boerhaave, Cullen, and Dr. James Gregory, have further extended.

Medicine, in examining the functions of the human body, considers those that relate to itself only, and others to external things. To the latter class belong those which, by physicians, are called the *animal functions;* to which are to be referred all our senses, as well as the power of voluntary motion, by which we become acquainted with the universe, and enjoy this earth. Among the functions which relate to the body, some have been named *vital*, such as the circulation of the blood and respiration; because, without the constant continuance of these, life cannot subsist; others, intended for repairing the waste of the system, have been termed the *natural functions;* for by the constant attrition of the solids and the evaporation of the fluid parts of the body, we stand in need of nourishment to supply the waste; after which the putrid and excrementitious parts must be thrown out by the proper passages. The digestion of the food, secretion of the humours, and excretion of the putrid parts of the food, are referred to this class; which, though necessary to life, may yet be interrupted for a considerable time without danger. This division of the functions into animal, vital, and natural, is of very ancient date, and is perhaps one of the best that has yet been proposed.

*Distinction of Diseases into Simple and Compound.* A disease takes place when the body has so far declined from a sound state, that its functions are either quite impeded, or performed with difficulty. A disease therefore may happen to any part of the body either solid or fluid, or to any one of the functions; and those may occur either singly, or several of them may be diseased at the same time; whence the distinction of diseases into simple and compound. We have examples of the most simple kinds of diseases, in the rupture or other injury of any of the corporeal organs, by which means they become less fit for performing their offices; or, though the organs themselves should remain sound, if the solids or fluids have degenerated from a healthy state; or if, having lost their proper qualities, they have acquired others of a different, perhaps of a noxious nature; or, lastly, if the moving powers shall become too weak or too strong, or direct their force in a way contrary to what nature requires.

*Symptoms.* The most simple diseases are either productive of others, or of symptoms, by which alone they become known to us. Every thing in which a sick person is observed to differ from one in health is called a symptom; and the most remarkable of these symptoms, which most commonly appear, define and constitute the disease.

*Predisponent Cause.* The causes of diseases are various; often obscure, and sometimes totally unknown. The most full and perfect proximate cause is that which, when present, produces a disease; when taken away, removes it; and when changed, changes it.—There are also remote causes, which physicians have been accustomed to divide into the predisponent and exciting ones. The former are those which only render the body fit for a disease, or which put it into such a state that it will readily receive one. The exciting cause is that which immediately produces the disease in a body already disposed to receive it.

*Exciting Cause.* The predisponent cause is always inherent in the body itself, though perhaps it originally came from without; thus heat or cold, a very sparing or a very luxurious diet, and many other particulars, may operate as causes of predisposition, inducing plethora, inanition, or the like: but the exciting cause may either come from within or without.

*Proximate Cause.* From the combined action of the predisponent and exciting causes comes the proximate cause, which neither of the two taken singly is often able to produce. A body predisposed to disease therefore has already declined somewhat from a state of perfect health, although none of its functions are impeded in such a manner that we can truly say the person is diseased. Yet sometimes the predisponent cause, by continuing long, may arrive at such a height, that it alone, without the addition of any exciting cause, may produce a real disease. The exciting cause also, though it should not be able immediately to bring on a disease; yet if it continues long, will by degrees destroy the strongest consitution, and render it liable to various diseases; because it either produces a predisponent cause, or is converted into it, so that the same thing may sometimes be an exciting cause, sometimes a predisponent one, or rather a cause of predisposition; of which the inclemencies of the weather, sloth, luxury, &c. are examples.

*Hereditary Diseases.* Diseases, however, seem to have their origin from the very constitution of the animal machine; and hence many diseases are common to every body when a proper exciting cause occurs, though some people are much more liable to certain diseases than others. Some are hereditary; for as healthy parents naturally produce healthy children, so diseased parents as naturally produce a diseased offspring. Some of these diseases appear in the earliest infancy; others occur equally at all ages; nor are there wanting some which lurk unsuspected even to the latest old age, at last breaking out with the utmost violence Some diseases are born with us, even though they have no proper foundation in our constitution, as when a fœtus receives some hurt by an injury done to the mother; while others, neither born with us, nor having any foundation in the constitution, are suckled in with the nurse's milk.

*Diseases from Age and Sex.* Many diseases accompany the different stages of life; and hence some are proper to infancy, youth, and old age. Some also are proper to each of the sexes; especially the female sex, proceeding, no doubt, from the general constitution of the body, but particularly from the state of the parts subservient to generation. Hence the diseases peculiar to virgins, to menstruating women, to women with child, to lying-in women, to nurses, and to old women.

*Diseases from Climate.* The climate itself, under which people live, produces some diseases; and every climate has a tendency to produce particular diseases, either from its excess of heat or cold, or from the mutability of the weather. An immense number of diseases also may be produced by impure air, or such as is loaded with putrid, marshy, and other noxious vapours. The same thing may happen likewise from corrupted aliment, whether meat or drink; though even the best and most nutritious aliment will hurt if taken in too great quantity; not to mention poisons, which are endowed with such pernicious qualities, that even when taken in a very small quantity they produce the most grievous diseases, or perhaps even death itself. Lastly, from innumerable accidents and dangers to which mankind are exposed, they frequently come off with broken limbs, wounds, and contusions, sometimes quite incurable; and these misfortunes, though proceeding from an external cause, often terminate in internal diseases.

*Diseases from Passions of the Mind.* Besides the dangers arising from those actions of the body and mind which are in our own power, there are others arising from those which are quite involuntary. Thus, passions of the mind, either when carried to too great excess, or when long continued, equally destroy the health; nay, will even sometimes bring on sudden death. Sleep also, which is of the greatest service in restoring the exhausted strength of the body, proves noxious either from its too great or too little quantity. In the most healthy body also, many things always require to be evacuated. The retention of these is hurtful, as well as too profuse an evacuation, or the excretion of those things either spontaneously or artificially, which nature directs to be retained. As the solid parts sometimes become flabby, soft, almost dissolved, and unfit for their proper offices; so the fluids are sometimes inspissated, and formed even into the hardest solid masses. Hence impeded action of the organs, vehement pain, various and grievous diseases. Lastly, some animals are to be reckoned among the causes of diseases; such, particularly, as support their life at the expense of others; and these either invade us from without, or take up their residence within the body, gnawing the bowels while the person is yet alive, with great danger and distress.

It would be foreign to our purpose to enter upon any analysis of the animal solids, their qualities, &c.; nor can we do more than enumerate the vital solids, or those which enjoy sense and mobility, as feeling, pain, anxiety, itching, taste, smell, hearing, sight, vertigo; memory, delirium, melancholy, and idiotism, which four last are properly internal senses. The disorders in the muscular power arise from too great mobility, vigour, torpor, debility, palsy, spasm;—sleep, the circulation of the blood, the pulsation of the arteries, palpitation, syncope, are all different disorders from the former; and diseases of the blood arise from plethora, inanition, morbid thinness, thickness, and acrimony;—the disorders of respiration are, coughs and sneezings; those of digestion embrace costiveness and looseness; such as proceed from the disorganization of the alimentary canal, are, dysentery, tenesmus, nausea, iliac passion, vomiting, cholera; from disorders in the secretory organs proceed excessive perspiration, suppression of urine, dysuria, strangury, urinary calculi, and scirrhus.

MEDIETAS LINGUÆ, a jury or inquest, whereof the one half consists of denizens, the other strangers, in pleas, wherein the one party is a stranger.

MEDIUM, in Logic, the mean or middle term of a syllogism, being an argument, reason, or consideration for which we affirm or deny any thing: or, it is the cause why the greater extreme is affirmed or denied of the less, in the conclusion.

Medium, in Arithmetic, or *Arithmetical Medium or Mean*, that which is equally distant from each extreme, or which exceeds the lesser extreme as much as it is exceeded by the greater, in respect of quantity, not of proportion; thus, 9 is a medium between 6 and 12.

Medium, *Geometrical*, is that where the same ratio is preserved between the first and second, as between the second and third terms, or that which exceeds the same ratio, or quota of itself, as it is exceeded: thus, 6 is a geometrical medium between 4 and 9.

Medium, in Philosophy, that space or region through which a body in motion passes to any point: thus, æther is supposed to be the medium through which the heavenly bodies move.

Medium, *Subtile* or *Æthereal*. Sir Isaac Newton makes it probable, that besides the particular aerial medium, wherein we live and breathe, there is another more universal one, which he calls an æthereal medium, vastly more rare, subtile, elastic, and active than air, and by that means freely permeating the pores and interstices of all other mediums, and diffusing itself through the whole creation; and by the intervention hereof, he thinks it is, that most of the great phenomena of nature are effected.

MEDUSA, in Natural History, a genus of the vermes mollusca class and order. They consist of a tender gelatinous mass of different figure, with arms proceeding from the lower surface: the larger species, when touched, cause a slight tingling and redness, and are usually denominated sea-nettles; they are supposed to constitute the chief food of cetaceous fish. Most of them shine with great splendour in the water.

MELANCHOLY, a species of insanity, supposed to arise from a redundancy of bile, which from disease becomes of a dark colour. *See* Medicine.

MELASIC ACID, found in molasses, supposed to be the same as the acetic acid.

MELEAGRIS, in Natural History, the turkey, a genus of birds of the order gallinæ. The wild turkey is a native of America, the presumed origin of every species under the genus. In the northern parts of that continent these birds are found in flocks of several hundreds, which during the day-time resort to the woods, feeding principally upon acorns, returning by night to some swampy grounds, where they roost upon the highest trees. In Carolina they occasionally grow to the weight of thirty pounds. Turkeys breed only once in a year, but will produce a great number at a time, sometimes seventeen. The female sits with extreme closeness, and is very assiduous in maternal duties. The young, however, are very susceptible of injury, from almost innumerable causes, from cold and wet, and even sunshine itself.

MELISSA OFFICINALIS. *Balm.*—This herb, in its recent state, has a weak, roughish, aromatic taste, and a pleasant smell, somewhat of the lemon kind. On distilling the fresh herb with water, it impregnates the first runnings pretty strongly with its grateful flavour. Prepared as tea, however, it makes a grateful diluent drink in fevers; and in this way it is commonly used, either by itself, or acidulated with the juice of lemons.

MELITTIS MELISSOPHYLLUM, and Melittis Grandiflora. *Bastard Balm.*—Both these plants are very beautiful, and are deserving a place in the flower garden: they are of easy culture, and will grow well under the shade of trees, a property that will always recommend them to the notice of the curious.

MELLATES, in Chemistry, a genus of salts formed from the mellitic acid.

MELLITE, or Honey Stone, in Mineralogy, takes its name from its yellow colour like that of honey. Its primitive figure is an octahedron. The crystals are small, their surface is commonly smooth and shining. Internally it is splendent. It is transparent, passing into the opaque, and possesses a double refraction. It is softer than amber, and brittle. Specific gravity is from about 1·5 to 1·7. It becomes electric by friction, but continues so only a short time. This mineral occurs on bituminous wood, an earthy coal, and is commonly accompanied with sulphur.

MELLITIC ACID, is procured from mellite reduced to powder, and boiled with about seventy-two times its weight of water, the alumina is precipitated in the form of flakes, and the acid combines with the water. By filtration and evaporation, crystals are deposited in the form of fine needles, or in small short prisms. The acid is not very soluble in water; its constituent parts are carbon, hydrogen, and oxygen. In combination with the earths, alkalies, and metallic oxides, it forms compounds denominated mellates.

MELODRAME. *See* Drama. A modern word for dramatic performances in which songs are intermixed.

MELODY, in Music, the agreeable effect of different sounds, ranged and disposed in succession, so that melody is the effect of a single voice or instrument, by which it is distinguished from harmony.

MELOE, a genus of insects of the order coleoptera. Thirty-five species have been described. The oil beetle, entirely blue-black or dark violet, is found in the advanced state of spring, in fields and pastures, creeping slowly, the body appearing so distended with eggs as to cause the insect to move with difficulty. On being roughly touched, it suddenly exudes a moisture from the pores, of a yellow colour, and of a very penetrating and peculiar smell. The female of this species deposits her eggs in a heap beneath the surface of the ground; from these are hatched the larvæ, which find subsistence by attaching themselves to other insects, and absorbing their juices. The blister-fly, or Spanish-fly, found chiefly in Spain, is an insect of great beauty, being entirely of the richest gilded grass green, with black antennæ. This is the cantharis of the shops, and the safest and most efficacious application for a blister plaster.

MENDICANTS, several orders of friars, who having no settled revenue, are supported by charitable contributions.

MENISCUS, a little moon, or rather a half-moon. A glass, concave on one side and convex on the other; as a watch glass.

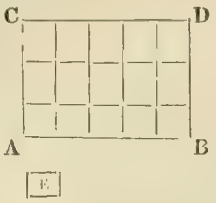
MENISPERMIC ACID, supposed to be found in the menispermum cocculus.

MENNONITES, a sect who believe that the New Testament is the only rule of faith; that the terms *person* and *trinity* are not to be used when speaking of the Father, Son, and Holy Ghost; that the first man was not created perfect; that it is unlawful to swear or to wage war upon any occasion; that infants are not the proper subjects of baptism; and that ministers of the gospel ought to receive no salary.

MENSTRUUM, *Solvent* or *Dissolvent*, any fluid that possesses the property of dissolving or separating the parts of solid bodies.

MENSURABILITY, capacity of being measured.

MENSURATION, that branch of Mathematics which treats of the measurement of the extensions, capacities, solidities, &c. of bodies; and which, in consequence of its very extensive applications to the various purposes of life, may be justly considered as one of the most important of mathematical sciences. It is highly probable, that this science in its more simple state may be traced to the origin of human society. When men began to multiply, and turn their attention to the cultivation of the earth, it became necessary to have some means of distinguishing the portions belonging to each individual or family, both as to situation and quantity. The same necessity dictated some means for enumerating their flocks and herds. Hence, the former gave rise to mensuration, and the latter to arithmetic. But although the invention of mensuration cannot be attributed to any one person or nation, its existence may be traced to Egypt at a very early age, where, though in its infancy, it assumed a scientific form, immediately connected with the overflowing of the Nile. After the Egyptians, the Greeks embodied this science into something like a regular system, and to them we are indebted for its elementary principles. In some of its kindred departments, Euclid, Archimedes, and Cavalerius have gained immortality; and until this science shall be lost, the names of Bonnycastle and Hutton cannot be forgotten. It is not consistent with the plan of this work to enter into details, but the clearness, simplicity, and rationality of its simple principles, may be gathered from the following observations:—Every quantity is measured by some other quantity of the same kind; as a line by a line, a surface by a surface, and a solid by a solid; and the number which shews how often the lesser, called the measuring unit, is contained in the greater, or quantity measured, is called the content of the quantity so measured. Thus, if the quantity to be measured be the rectangle A B C D, and the little square E, whose side is one inch, be the measuring unit, then, as often as the said little square is contained in the rectangle, so many square inches the rectangle is said to contain: so that if the length D C be supposed 5 inches, and the breadth A D 3 inches, the content of the rectangle will be 3 times 5, or 15 square inches: because, if lines be drawn parallel to the sides, at an inch distance one from another, they will divide the whole rectangle A B C D into 3 times 5, or 15 equal parts, of one inch each. And, generally, whatever the measures of the two sides may be, it is evident that the rectangle will contain the square E, as many times as the base A B contains the base of the square, repeated as often as the altitude A D contains the altitude of the square. Hence we have the following rule for any parallelogram whatever:—To find the area of a parallelogram, whether it be a square, a rectangle, a rhombus, or a rhomboides. Multiply the length by the perpendicular height, and the product will be the area.



**MENTHA VIRIDIS.** *Spear-mint.*—The virtues of mint are those of a warm stomachic and carminative: in loss of appetite, nausea, continual retchings to vomit, and (as Boerhaave expresses it) almost paralytic weaknesses of the stomach, there are few simples perhaps of equal efficacy. In colicky pains, the gripes to which children are subject, lienteries, and other kinds of immoderate fluxes, this plant frequently does good service. It likewise proves beneficial in sundry hysteric cases, and affords an useful cordial in languors and other weaknesses consequent upon delivery. The best preparations for these purposes are, a strong infusion made from the dry leaves in water (which is much superior to one from the green herb) or rather a tincture or extract prepared with rectified spirit. The essential oil, a simple and spirituous water, and a conserve, are kept in the shops: the Edinburgh College directs an infusion of the leaves in the distilled water. This herb is an ingredient also in the three alexiterial waters; and its essential oil, in the stomach plaster and stomachic pills.

**Mentha Piperita.** *Pepper-mint.*—The leaves have a more penetrating smell than any of the other mints, and a much warmer, pungent, glowing taste like pepper, sinking as it were into the tongue. The principal use of this herb is in flatulent colics, languors, and other like disorders; it seems to act as soon as taken, and extends its effects through the whole system, instantly communicating a glowing warmth. Water extracts the whole of the pungency of this herb by infusion, and elevates it in distillation. Its officinal preparations are an essential oil, and a simple and spirituous water.

**Mentha Pulegium.** *Pennyroyal.*—Pennyroyal is a warm pungent herb of the aromatic kind, similar to mint, but more acrid and less agreeable. It has long been held in great esteem, and not undeservedly, as an aperient and deobstruent, particularly in hysteric complaints, and suppressions of the uterine purgations. For these purposes, the distilled water is generally made use of, or, what is of equal efficacy, an infusion of the leaves. It is observable, that both water and rectified spirit extract the virtues of this herb by infusion, and likewise elevate greatest part of them in distillation.

**MENYANTHES TRIFOLIATA.** *Buck-bean.*—The leaves of this plant yield an efficacious aperient and deobstruent; it promotes the fluid secretions, and, if liberally taken, gently loosens the belly. It has of late gained great reputation in scorbutic and scrofulous disorders; and its good effects in these cases have been warranted by experience: inveterate cutaneous diseases have been removed by an infusion of the leaves, drunk to the quantity of a pint a day, at proper intervals, and continued some weeks. Boerhaave relates, that he was relieved of the gout by drinking the juice mixed with whey.

**Menyanthes Nymphoides.** *Round-leaved Bog Bean.*—This is a beautiful aquatic, and claims a place in all ornamental pieces of water.

**MERCATOR, Gerard,** an eminent geographer and mathematician, was born in the Low Countries in 1512; to whom we are indebted for the construction of those sea-charts called after him Mercator's charts, as also for that part of navigation which is after him called Mercator sailing. He died at Duisbourg in 1594.

**Mercator,** *Nicholas*, a celebrated mathematician and astronomer, was born at Holstein in 1640; but spent all the latter part of his life in England, and was admitted a fellow of the Royal Society. He is said to have possessed considerable talents, but was not of a very liberal turn of mind. Having made himself master of the analogy between a scale of logarithmic tangents and Wright's protraction of the nautical meridial line, which consisted of the sums of the secants, though it did not appear by whom this analogy was first discovered, and being desirous of making the most advantage of this and another invention in navigation, he, by a paper in the Phil. Trans. for June, 1666, invited the public to enter into a wager with him on his ability to prove the truth or falsehood of the supposed analogy! This proposal, not very reputable to a man of science and literature, was not taken up by any one, and Mercator reserved his demonstration; he however distinguished himself by many valuable pieces on philosophy and mathematical subjects. He died at the age of 55, in the year 1694.

**MERCHANT,** a person who buys and sells commodities in gross, or deals in exchanges; or that traffics in the way of commerce, either by importation or exportation.

**MERCURIALIS ANNUA.** *Annual Dog's Mercury.*—Persons who are in the habit of gathering wild herbs to cook, should be careful of this. It grows plentifully in all rich grounds, and is common with fat-hen and the other herbs usually collected for such purposes in the spring, and from which it is not readily distinguished: at least, we cannot describe a difference that a person, ignorant of botany, can distinguish it by.

**MERCURY,** is a metal, which in our climate is always fluid, but in intense cold it becomes solid, and then resembles silver in appearance, and is malleable.—It is sometimes found native, but much more frequently combined with sulphur, when it is denominated cinnabar. It is separated from the sulphur by distillation with quick-lime or iron filings. Mercury is obtained abundantly in the Austrian territories, and in South America. Mercury has a great affinity to other metals. Dip a shilling in mercury, it will be encrusted over, and will require to be rubbed very much before the mercury is got off. The same circumstance will occur if any other metal be put in mercury. Rub some quicksilver and tinfoil together, and they will unite into one mass. Such a composition is called an amalgam. Mercury and lead will also combine. If lead, bismuth, and mercury, are united together, the amalgam will be equally fluid with the simple mercury itself.—From this circumstance, dishonourable dealers frequently impose on the public this impure composition, and, when the metal is to be used medically, dangerous consequences are the result. Mercury is used in barometers, thermometers, in silvering looking-glasses, and forming amalgams for gilding and silvering metals: also in the making of vermilion. In countries where there are gold and silver mines, it is employed in separating the precious metals from extraneous matter. Mercury is nearly fourteen times the weight of water, and is the heaviest of all metals after gold and platinum. In consequence of its great weight, if a piece of stone, iron, lead, or silver, be put in a cup of mercury, it will float in the same manner, and for exactly the same reason, as a piece of wood in water. Mercury is readily soluble in acids, as may easily be ascertained, and from its very extensive use in medicine, there are innumerable preparations of it, by which it may be exhibited in powders, pills, or drops to the patient. The most usual is calomel, which is a preparation of mercury and muriatic acid. One preparation of mercury, named corrosive sublimate, is a most deadly poison. Mercury will readily unite with sulphur. Melt some sulphur in a crucible on the fire, and then add a little mercury, and stir the whole together, and a sulphuret of mercury, or cinnabar, will be formed. Vermilion is a beautiful scarlet pigment, prepared from mercury and sulphur, and is called by chemists the red sulphuretted oxide of mercury. The property of mercury dissolving a certain portion of gold and silver, enabled alchymists to impose upon mankind, and make it appear as if they had succeeded in a small degree in discovering the secret of turning metals into gold and silver. In their operations they employed mercury, in which small portions of these metals had been dissolved; and as the mercury was evaporated by great heat, and left the gold and silver behind, the bystanders were made to believe that these metals had actually been produced in operation by the skill of the experimentalist. Calomel is now called, in the nomenclature of the day, the protochloride of mercury, and corrosive sublimate is called the deutochloride. Mercury freezes at 39° below Zero, and boils at 656° Fahrenheit.—Mercury being habitually fluid, very readily combines with most of the metals, to which it communicates more or less of its fusibility. When these metallic mixtures contain a sufficient quantity of mercury to render them soft at a mean temperature, they are called amalgams. It very readily combines with gold, silver, lead, tin, bismuth, and zinc; more difficultly with copper, arsenic, and antimony; and scarcely at all with platina or iron. Looking-glasses are covered on the back surface with an amalgam of tin. Some of the uses of mercury have already been mentioned in the present article. The amalgamation of the noble metals, water-gildings, the making of vermilion, the silvering of looking-glasses, the making of barometers and thermometers, and the preparation of several powerful medicines, are the principal uses to which the metal is applied.—Scarcely any substance is so liable to adulteration as mercury, owing to the property which it possesses of dissolving completely some of the baser metals. This union is so strong, that they even rise along with the quicksilver when distilled. The impurity of mercury is generally indicated by its dull aspect; by its tarnishing, and becoming covered with a coat of oxide, on long exposure to the air; by its adhesion to the surface of glass; and when shaken with water in a bottle, by the speedy formation of a black powder. Lead and tin are frequently impurities, and the mercury becomes capable of taking up more of these if zinc or bismuth be previously added.

Mercury, in Astronomy, is the nearest planet to the sun, denoted by the character ☿: its mean distance being ·387, that of the earth being considered as unity; which makes that distance above 36 millions of miles. He performs his sidereal revolution in $87^{d}\ 23^{h}\ 15'\ 43''{\cdot}9$, and his mean synodical revolution in about 116 days. The eccentricity of his orbit is ·2055; half the major axis being taken equal to unity. His mean longitude, at the commencement of the present century, was in $5^{s}\ 3^{\circ}\ 56'\ 27''{\cdot}0$. The longitude of his perihelion was, at the same time, in $2^{s}\ 14^{\circ}\ 21'\ 46''{\cdot}9$; but the line of the apsides has a sidereal motion, according to the order of the signs, equal to $9'\ 43''{\cdot}6$ in a century. Which motion, if referred to the ecliptic, will (owing to the precession of the equinoctial points) be equal to $55''{\cdot}8$ in a year; or to $1^{\circ}\ 33'\ 13''{\cdot}6$ in a century. The orbit of Mercury is inclined to the plane of the ecliptic in an angle of $7^{\circ}\ 0'\ 9''{\cdot}1$; but this angle is subject to a small increase of about $18''{\cdot}2$ in a century. His orbit, at the commencement of the present century, crossed the ecliptic in $1^{s}\ 15^{\circ}\ 57',\ 30''{\cdot}9$: having a sidereal motion to the westward every century, of $13'\ 2''{\cdot}2$; but if referred to the ecliptic, the place of the nodes will (on account of the precession of the equinoxes) fall more to the eastward by $42''{\cdot}3$ in a year, or $1^{\circ}\ 10'\ 27''{\cdot}8$ in a century. The rotation on his axis is accomplished in $1^{d}\ 0^{h}\ 5'\ 28''{\cdot}3$, but the inclination of its axis is not known. The diameter of Mercury is about 3123 miles: which, compared with the earth's diameter considered as unity, is about ·3944; his apparent diameter being $6''{\cdot}9$. His mass, compared with that of the sun considered as unity, is $\frac{1}{2025810}$, and the proportion of light and heat received from the sun is about 6·68 times greater than on our planet. As seen from the earth, Mercury never appears at any great distance from the sun; either in the morning or the evening; his elongation, or angular distance, varying only from 16° 12′ to 28° 48′. *See* Astronomy. His course sometimes appears retrograde, the mean arc, which it describes in this case, being about 13° 30′; and its mean duration is about 23 days; but there is great difference in this respect. This retrogradation commences or finishes when he is about 18° distant from the sun. Mercury changes his phases, like the moon, according to his various positions with regard to the earth and sun: but this cannot be discovered without the aid of a telescope. This planet is sometimes seen to pass over the sun's disc: which can only happen when he is in his nodes, and when the earth is in the same longitude; consequently this phenomenon can take place only in the month of May or November. The first observation of this kind was made by Gassendi, in November 1631: since which period they have been frequent; the last occurred in 1822.

Mercury, in the science of Heraldry, a term used in blazoning by planets, for the purple colour used in the arms of sovereign princes.

MERGER, in Law, is where a less estate in lands, &c. is drowned in the greater.

MERGUS, in Ornithology, a genus of birds of the order anseres. There are ten species: M. merganser, the goosander, weighs about four pounds, and is twenty-eight inches long. It is common in the northern regions of Europe and Asia, and is found in the Orkneys during the whole year. It builds generally in the holes and fissures of rocks, and feeds on fish. Its flesh is strong, and seldom used for food. The smew is about 18 inches long, the head is adorned with a long crest, white above and black beneath, the tail of a deep ash-colour. The legs bluish gray; the rest of the body white. The red-breasted goosander, considerably less than the former, is found also in the same latitudes, and breeds in the north of Scotland. It dives excellently, and is extremely alert on the water. These birds, like the other species of the genus, subsist in a great degree on fish. They fly near the surface of the water with great vigour, and their bills are admirably adapted to secure their prey.

MERIDIAN, in Astronomy, (from the Latin *meridies*, midday,) is a great circle of the celestial sphere, passing through the poles of the world and zenith and nadir, crossing the equator at right angles, and dividing the sphere into an eastern and western hemisphere. When the sun is south of this circle it is noon, or mid-day, to all places situated under that meridian, whence the derivation of the word as above stated.

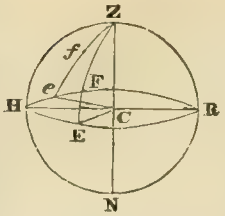
Meridian, in Geography, a corresponding terrestrial circle in the plane of the former, and which therefore passes through the poles of the earth. All places situated under the same meridian have their noon or midnight at the same time; but under different meridians, it will arrive sooner or later, according as they are situated to the eastward or westward of each other, *viz.* the sun will be upon that meridian soonest which is most to the eastward, and that at the rate of an hour for every 15 degrees.

*First* Meridian, is that from which all the others are reckoned, which being totally arbitrary, has been variously chosen by different geographers. Ptolemy makes his first meridian pass through the most western of the Canary Islands, others have chosen Cape Verd, some the Peak of Teneriffe, others the island of Fero, &c.; but most nations now consider that the first meridian which passes over their metropolis, or their principal observatory. Thus the English reckon from the meridian of London, or rather of Greenwich; the French from that of Paris; the Spanish from Madrid, &c.

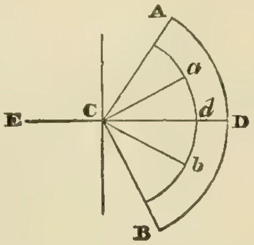
Meridian *of a Globe*, is the brazen circle in which it turns, and by which it is supported.

The *Brazen* Meridian, is divided into 360 equal parts, called degrees. In the upper semicircle of the brass meridian these degrees are numbered from 0 to 90, or from the equator towards the poles, and are used for finding the latitudes of places. On the lower semicircle of the brass meridian they are numbered from 0 to 90; from the poles towards the equator, and are used in the elevation of the poles.

Meridian *Line*, is a north and south line, the exact determination of which is of the greatest importance in all cases relating to astronomy, geography, dialling, &c. because on this all the other parts have their dependence. The most celebrated meridian line is that on the pavement of the church of St. Petronio in Bologna, which was drawn to the length of one hundred and twenty feet by the celebrated Cassini.



*To Draw a Meridian Line.*—Knowing the south quarter pretty nearly, observe the altitude F E of some star on the eastern side thereof, not far from the meridian H Z R N; then keeping the quadrant firm on its axis, so as the plummet may still cut the same degree, only directing it to the western side of the meridian, wait till you find the star has the same altitude as before *f*, *e*. Lastly, bisect the angle E *e*, formed by the intersection of the two planes wherein the quadrant is placed at the time of the two observations, by the right line H R. This H R is a meridian line. Or thus: On the horizontal plane, from the same centre C, describe several arcs of circles B A, *b a* and *e*, and on the same centre C erect a stile, or gnomon, perpendicular to the plane A C B, a foot or half a foot long. About the 21st of June, between the hours of nine and eleven in the morning, and between one and three in the afternoon, observe the points B, *b*, &c. A, *a*, wherein the shadow of the stile terminates. Bisect the arcs A B, *a b*, &c. in D, *d*, &c. If then the same right line D E bisect all the arcs A B, *a b*, &c. it will be the meridian line sought. As it is difficult to determine the extremity of the shadow exactly, it is best to have the stile flat at top, and to drill a little hole, noting the lucid spot projected by it on the arcs A B, and *a b*, instead of the extremity of the shadow. Otherwise, the circles may be made with yellow, instead of black, &c. Several authors have invented particular instruments and methods for the describing of meridian lines, or rather for determining equal altitudes of the sun in the eastern and western parts of the heavens; but as the former of the methods above delivered suffices for astronomical observations, and the latter for more ordinary occasions, we shall omit giving any descriptions of them.



Meridian *Line*, on a dial, is the same as the 12 o'clock hour line. *Meridian Line*, on the Gunter's scale, is a line divided unequally towards 87°, corresponding to the meridian in Mercator's chart.

*Magnetic* Meridian, a great circle passing through the magnetic poles.

Meridian *Altitude*, the altitude of any of the heavenly bodies when they are upon the meridian.

MERIDIONAL Distance, in Navigation, is of the same import as Departure, or distance between the meridians of two places.

Meridional *Parts*, *Miles*, or *Minutes*, in Navigation, are the parts of the increased meridians according to the Mercator chart. The parts of the enlarged meridians in the Mercator chart increase in proportion to the cosines of the latitudes to radius, or as the radius to the secants, or since the radius is constant, they increase simply as the secants; and therefore the whole enlarged meridian for any parallel of latitude will be proportional to the sum of all the secants to that place, which, for common purposes, are found near enough by adding together the secants of every angle in minutes; that is,

the meridional parts
for $1' = \text{sec. } 1'$
for $2'' = \text{sec. } 1' + \text{sec. } 2'$.
for $3''' = \text{sec. } 1' + \text{sec. } 2' + \text{sec. } 3'$.
&c. &c.

and this way they were first computed by Wright. But it is obvious, that this is merely an approximation, and at the same time attended with considerable labour; other methods have therefore been invented for this purpose by Bond, Gregory, Halley, Robertson, &c. See the latter author's Treatise on Navigation, vol. ii. book 8. But if the earth be considered as a spheroid, the method of computation is a little more varied, though it is attended with the same accuracy as in the former case. See Dr. Jamieson's Treatise on the Construction of Maps.

MERLIN. *See* Falco.

MEROPS, a genus of birds of the order picæ. Gmelin notices twenty-six species, and Latham twenty. The common bee-eater, is about ten inches long, and found in many countries of Europe, though never observed in Great Britain. It is particularly fond of bees, but will eat various other insects; many of which it seizes, like the swallow, on the wing. When insects are with difficulty to be found, it feeds on many species of seeds.

MESNE, he who is lord of a manor, and has tenants holding of him, yet himself holds of a superior lord.

Mesne *Process*, an intermediate process which issues pending the suit, upon some collateral interlocutory matter. Sometimes it is put in contradistinction to final process, or process of execution; and then it signifies all such process as intervenes between the beginning and end of a suit.

MESPILUS, in Botany, a genus of the icosandria pentagynia class and order.—Natural order of pomaceæ. There are nine species. The Dutch or common medlar never rises with an upright trunk, but sends out crooked deformed branches, not far from the ground; leaves large, entire, downy, on their under side: flowers very large, as also the fruit, which approaches to the shape of an apple. This tree, bearing the largest fruit, is now generally cultivated: the Nottingham medlar has a more poignant taste, but the fruit is considerably less.

MESSENGERS, are certain officers chiefly employed under the direction of the secretaries of state, and always in readiness to be sent with all kinds of despatches, foreign and domestic. They also, by virtue of the secretaries' warrants, take up persons for high treason, or other offences against the state.

METALLURGY, comprehends the whole art of working metals, from the state of ore to the utensil; hence, assaying, gilding, refining, smelting, &c. are only branches of metallurgy. In a more limited sense, it includes only the operations which are followed in separating metals from their ores.

METALS. Gold occurs in a metallic state, alloyed with a little silver or copper, in the mines of Germany, Hungary, and America, in veins, and disseminated in granite, gneiss, porphyry, and schist; in flakes, massive, and in grains, of a yellow colour, shining, opake, and of a metallic lustre. Pure gold, chemically obtained, is of a deep yellow colour; it melts at a bright red heat, and, in fusion, appears of a brilliant green; and it forms compounds with most of the gaseous and simple combinations.

Silver occurs in nature pure, and alloyed with gold, antimony, arsenic, and bismuth. Common native silver occurs in veins, in the middle or upper parts when traversing granite, gneiss, mica slate, and porphyry, in primitive mountains; and wacke, in transition ores in Cornwall, Saxony, Hungary, and Mexico; in crystals, massive, and in leaves; of a whitish splendent metallic lustre, and opake. Auriferous native silver, containing a portion of gold, was formerly found in the mines of Konigsberg, in Norway, and at present in those of Schlangenberg in Siberia. It melts at a cherry-red heat, in fusion is very brilliant, and is not oxidized by exposure to air.

Platinum is found in small grains and rolled pieces, in alluvial soil, along with gold, silver, osmium, iridium, zirconium, and quartz, in New Grenada and Brazil, of a steel gray colour and shining lustre. This substance is dissolved in nitro-muriatic acid, then precipitated by a solution of muriate of ammonia; this is repeated, and the second precipitate heated while hot, leaves pure platinum,—a white metal very difficult of fusion, and unaltered by the joint action of heat and air.

Palladium, Rhodium, Iridium, and Osmium, have much resemblance in lustre, and all are obtained from crude platinum; but only the first is malleable.

Mercury occurs rarely in primitive and transition rocks; more frequently in those of the coal formation; in Deux Ponts, Idria, and other European mining districts. The principal ore is native cinnabar, whence the mercury is chemically separated. It is a brilliant tin-white metal, with a blue tint, opake, splendent, and metallic; liquid at all common temperatures.

Copper is found native, and in various states of combination. It occurs in crystals, and massive, in granite, gneiss, mica slate, clay slate, primitive limestone, and serpentine; often in small veins, also in grains, and sometimes in blocks many pounds weight, in alluvial districts; in serpentine in Shetland,

and in the Cornish copper mines. Large masses occur in the northern part of North America. It has a fine red colour, much brilliancy, is very malleable and ductile, has a peculiar smell when warmed or rubbed, and melts at a cherry-red or dull white heat.

Tellurium occurs in wacke in Transylvania, and also in Tellemark in Norway, granular, massive, and disseminated, of a tin-white colour, shining metallic lustre, rather brittle, and easily frangible, fusible, and very volatile.

Iron is of a blue-white colour, very malleable and ductile, and fusible at a white heat. The most important native combinations, whence are drawn the immense supplies for the arts of life, are the oxides. It is combined with sulphur, and several acids; also some vegetable and animal bodies, and is so abundant that few fossils are devoid of it. The different ores are found often in thick beds in the primitive rocks, gneiss, hornblende slate, granite, &c. less in transition rocks, in veins, beds, and masses in porphyry.

Tin has a silvery-white colour, is malleable, but sparingly ductile; it is obtained by heating red with charcoal the native ore, which in all its varieties occurs in granite, gneiss, porphyry, and alluvial deposits, in the Cornish mines, in crystals, and concretions, of various colours, splendent, adamantine lustre; semitransparent to opake.

Zinc is a blueish-white metal, malleable, but very brittle about the point of fusion, (680°;) the ore occurs in New Jersey and Sussex, North America, of a red colour, massive, translucent, and opake. The oxide occurs in veins of galena, and clay slate, and in beds in masses, in the mines of Flint and Leicestershires; in crystals, and concretions, dull lustre, opake; when the metal is red, it inflames, burns bright, and is converted into a white tasteless flocculent substance, soluble in alcalies, and called *philosopher's wool.*

Manganese is of a blueish-white colour, very brittle, and difficult of fusion; and becomes an oxide when exposed to the air. The ore is found native in great abundance, in veins in primitive rocks; in crystals and concretions of a grayish-black colour, massive, glimmering, opake. Maganese of a brown and red colour occurs at Kapuic, in Transylvania, and at Catherineberg, in Siberia; and in Sweden, in beds of magnetic iron ore, in gneiss, manganese spar occurs massive, of a bright rose-red colour.

Potassium is a white metal of great lustre; (obtained by decomposing, by the action of iron at a white heat, the substance called caustic potash,) on exposure to air it instantly tarnishes; it is ductile, and of the consistency of soft wax; when cold it is hard and brittle; it easily fuses; heated in air, it burns with a brilliant white flame, and at bright red heat rises in vapour.

Sodium (obtained from soda by a method analogous to that for obtaining potassium) in colour resembles lead, easily fuses, is volatile at a white heat, burns when heated in contact with air, and thrown on water produces violent action, but the metal does not often inflame.

Bariumis obtained from an amalgam of the earth baryta and mercury negatively electrized; and the mercury then expelled by heat, leaves the metal, of a dark gray colour, more than twice the weight of water; it greedily absorbs oxygen, and gently heated burns with a deep red light.

Lead occurs in galena veins at Leadhills, Wanlockhead, and the Paris mine in Anglesea, in crystals, granular and massive, of a blueish-white colour mostly, adamantine lustre, from splendent to shining, and translucent; and convertible into an oxide by the united action of heat and air.

Nickel occurs native in Scotland, at Leadhills, and Wanlockhead, and in the Coal-field of West Lothian; it occurs in silver and cobalt veins in gneiss, mica slate, clay slate, and sienite; also in bituminous marl slate, granular, massive; brittle, coppery-red, shining, and metallic lustre.

Arsenic exists in nature nearly pure, in the mines of Germany, Norway, Russia, and France, and frequently occurs, combined with other metallic substances, in metalliferous veins, where they cross each other, in gneiss, mica slate, clay slate, and porphyry, massive, in plates, of a tin-white colour, soon tarnishing; glistening metallic lustre; it is very inflammable, fusible, and volatile; and highly poisonous.

Molybdenum is of a whitish-gray colour, and with extreme difficulty fused.

Chrome ore occurs in veins and beds in serpentine and trap, in Scotland and Shetland, in crystals and granular, grayish, shining, and opake; the metal is white, brittle, and of very difficult fusion.

Tungsten is a native tung state of lime, and Wolfram is the same of tungstic acid, iron, and manganese. They occur in Cornwall, sometimes in crystals, granular, massive; of a white, brown, and yellow colour, shining and splendent, resinous, translucent; the metals in colour resemble iron, are hard and brittle.

Columbium was first discovered by Mr. Hatchett in a mineral from North America. Little is yet known of its properties.

Strontian is procured from the earth strontia, by the same process as Barium; which metal it much resembles; but it is not poisonous.

Uranium. The oxide of sulphuret occurs native in the mines of Cornwall, in crystals, green, splendent, and translucent; hence the metal is obtained of a gray colour, and with difficulty fused.

Cerium is obtained from a mineral named Cesite, which occurs in a bed of copper at Ridderhyttan, in Sweden.

Cobalt is of a gray colour, brittle, and difficult of fusion, obtained by a very complex process from the ores, which occur at various places in Norway, Sweden, and Britain.

Bismuth is a brittle, brilliant white metal, with a slight tint of red; not easily fused, and on cooling always crystallizes; is affected by heat and air. With gold, platinum, and tin, it forms brittle compounds.

Calcium is a white metal, obtained (like Barium,) from lime; which, exposed to air, and gently heated, burns in a whitish flame.

Of numerous new minerals we select the following from Dr. Brewster's Edinburgh Journal of Science for 1825:

Roselite, a new mineral, of a deep red rose colour, contains water, oxide of cobalt, lime, arsenic acid, and magnesia.

Columbite, from America, contains 30 per cent. of manganese.

Brochantile, of an emerald green colour, is met with in massive red copper, from the Bank mine, Ekatherineburg, Siberia.

Fluéllite, compounded of alumina and fluoric acid, is whitish and prismatic.

Torrelite, from America, is composed of silica, lime, and iron.

Hyalosiderite, a new mineral, occurs in small crystals, sometimes imperfectly formed. in a basaltic amygdaloid of a reddish-brown colour, at Breisgaw, in Germany. This is a species of *volcanic iron glass;* magnetic if gently heated, and fusible in a high temperature. Specific gravity = 2·875.

Hopeite, a new mineral, prismatic in form, grayish-white in colour, and translucent. Specific gravity = 2·76. It is soluble in acids, without effervescence. It is found near Aix-la-Chapelle.

Childrenite, a new mineral, whose hardness is so great that it scratches glass, and is found near Tavistock in Devonshire, on the surface of quartz. Its constituent parts are iron and alumina, and it resembles in appearance sparry iron ore and heavy spar.

Somervillite, a new mineral, of a pale yellow, hard and fusible into greenish globules. It is found about Vesuvius.

Nuttalite, a new mineral, found imbedded in calcareous spar, soft, and glassy in its fracture. Of American origin.

Babingtonite, a new mineral, brilliant, black, scratches glass, and is composed of iron, silica, and manganese.

Sillimanite, a new mineral, occurs crystalized, dark-gray colour, brilliant upon the single face of clearage, harder than topaz, brittle and easily reduced to powder; specific gravity = 3·410. It is met with in Connecticut.

Baryto-Calcite, a new mineral, of a grayish tinge; specific gravity = 3·66; it consists of carbonate of barytes and carbonate of lime, with traces of iron and manganese.

METAMORPHOSIS, the change of a person or thing into another form. Most of the ancient metamorphoses include some allegorical meaning, relating either to physics or morality. Some authors are of opinion, that a great part of the ancient philosophy is couched under them.

**METAPHOR**, the application of a word to a use to which in its original import it cannot be put, as "he bridles his anger," "the golden harvest."

**METAPHYSICS**, the science which considers beings as abstracted from all matter, particularly beings purely spiritual, as God, angels, the human soul; or it may be defined, the science of the principles and causes of all things existing. Hence it is, that mind or intelligence, and especially the supreme intelligence, which is the cause of the universe, and of every thing which it contains, is the principal subject of this science. The word originated with Aristotle, who has termed a treatise which chiefly relates to the intellectual world, and which is placed after his physics, (*see* Physics,) Meta ta phusis. So that it may mean either something "beyond physics," or merely "an appendix to physics," or natural history.

**METEMPSYCHOSIS**, from *meta*, again, *em*, in, and *psuche*, the soul. Transmigration, or the supposed passage of the soul from one body to another. Pythagoras and his followers believed that after death men's souls passed into other bodies, of this or that kind, according to the manner of life they had led. If they had been vicious, they were imprisoned in the bodies of miserable beasts, there to do penance for several ages, at the expiration whereof they returned afresh to animate men. But if they lived virtuously, some happier brute, or even a human creature, was to be their lot. Pythagoras is supposed to have borrowed this from the ancient Brachmans, (certain inhabitants of India.) The notion still makes the principal foundation of their religion. Many not only forbear eating any thing which has life, but even refuse to defend themselves from wild beasts.

**METEOR.** This term is by some writers made to comprehend all the visible phenomena of meteorology, but it is more generally confined to luminous bodies, appearing suddenly at uncertain times, and with more or less of motion in the atmosphere. These may be reduced under three classes, *viz.* fire balls, falling or shooting stars, and ignes fatui. In tropical climates these meteors are more common and more stupendous than in these more temperate regions. But they sometimes also visit the more genial regions of Europe. Two of them appeared in England in the year 1783, the first of them was seen on the 18th of August, and was, in appearance, a luminous ball, which rose in the N. N. W. nearly round; it however soon became elliptical, and gradually assumed a tail as it ascended, and in a certain part of its course, seemed to burst, after which it proceeded no longer as an entire mass, but was apparently divided into a cluster of balls of different magnitudes, and all carrying or leaving a train behind, till having passed the east, and verging considerably to the south, it gradually descended, and was lost out of sight. The time of its appearance was about sixteen minutes past nine in the evening, and it was visible about half a minute. It was seen in all parts of Great Britain, at Paris, at Nuits, in Burgundy, and even at Rome; and is supposed to have described a tract of 1000 miles at least over the surface of the earth. The illumination of these meteors is often so great as to totally obliterate the stars, to make the moon look dull, and even to affect the spectators like the sun itself. The body of the fire ball, even before it bursts, did not appear of a uniform brightness, but consisted of lucid and dull parts, which were constantly changing their respective positions, so that the whole effect was like an internal agitation or boiling of the matter. Its height seems to have varied from 55 to 60 miles. A report was heard some time after the meteor disappeared, and this report was loudest in Lincolnshire and the adjacent parts, and again in the eastern parts of Kent. Judging from the height of the meteor, its bulk is conjectured to have been not less than half a mile in diameter; and when we consider this bulk, its velocity cannot fail to astonish us, which is supposed to be at the rate of more than 40 miles in a second.

Dr. Blagden is of opinion, that the general cause of these phenomena is electricity; but we cannot subscribe to this opinion. The duration of the fire-ball, the unequal consistency of the mass, and several other points in the narration, seem to indicate that its materials were of a less rare and evanescent nature than the electric fire.

The shooting or falling star is a common phenomenon; but though so frequently observed, the great distance and transient nature of these meteors have hitherto frustrated every attempt to ascertain their cause. The connexion of these with an active state of the atmospheric electricity, is, however, certain from observation; and we have more reason to consider them as electric scintillæ than as solid or fluid matter in the act of combustion. They precede a change of wind. Concerning the nature and composition of the *ignis fatuus*, or will-with a-wisp, there is less dispute, the generality of philosophers being agreed, that it is caused by some volatile vapour of the phosphoric kind, probably the phosphorized hydrogen gas. The light from putrescent substances, particularly putrid fish, and those sparks emitted from the sea or sea water when agitated, in the dark, correspond in appearance with this meteor.

**METEORIC** Stones. *See* Aerolites.

**METEOROLOGY**, the application of natural philosophy to the constant or variable phenomena going on in the mass of the atmosphere, or at the surface of the earth, by the general action of natural agents, such as heat, electricity, and magnetism. In it are comprehended the unequal distribution of heat upon the earth, the laws of its variations in the different seasons of the year, the decrease of density, and the falling of the temperature of the atmospheric strata at different heights, winds, clouds, fogs, rain, snow, hail, thunder, and water-spouts.

The leading facts respecting Meteorology are summed up by Mr. Daniels in the following propositions.—1. The mean height of the barometer at the level of the sea is the same in every part of the globe. 2. The barometer constantly descends in a geometrical progression, for equal ascents in the atmosphere subject to a correction for the decreasing temperature of the elevation. 3. The mean temperature of the earth's surface increases gradually from the poles to the equator. 4. The mean temperature of the atmosphere decreases from below upwards in a regular gradation. The fact is sufficiently established by numerous observations. Mr. Dalton was the first to demonstrate the natural equilibrium of heat in an atmosphere, is when an atom of air, in the same perpendicular column, is possessed of the same quantity of heat, and consequently that an equilibrium results when the temperature gradually diminishes in ascending. This is the natural consequence of the increased capacity for heat derived from rarefaction; when the quantity of heat is limited, the temperature must be regulated by the density.

5. The barometer at the level of the sea is but very slightly affected by the annual or diurnal fluctuations of temperature. 6. The barometer in the higher regions of the atmosphere is greatly affected by the annual or diurnal fluctuations of temperature. This observation is easily confirmed in various ways, but it is sufficient to refer for its correctness to those valuable registers which are simultaneously kept at Geneva, and the summit of Mount St. Bernard.

7. The heating and cooling of the atmosphere by the changes of day and night take place equally throughout its mass. This is fully established by the same series of observations. 8. The average quantity of vapour in the atmosphere decreases from below upwards, and from the equator to the poles. This consequence is obviously derivable from the preceding laws of temperature, and is moreover amply confirmed by experiment. 9. The condensation of elastic vapour into cloud raises the temperature of the air. In confirmation of this theoretical and practical conclusion, the observation of M. de Luc may be adduced.

10. Another remarkable phenomenon is, that there exists a general tendency in the wind to blow from north to east, and south-east towards the equator in latitudes below 30°. 11. While the trade wind blows upon the surface of the earth, a current flows in the contrary direction at a great elevation in the atmosphere. This necessary consequence of the theory of the trade winds, rested for a long time upon theoretical conclusions only; the eruption, however, of the volcano in the island of St. Vincent, in the year 1812, placed the fact beyond dispute. The island of Barbadoes is situated considerably to the east of St. Vincent, and between the two the trade wind continually blows, and with such force that it is with considerable difficulty and only by making a very long circuit, that a ship can sail from the latter to the former; notwithstanding this, during the erup-

tion at St. Vincent, dense clouds were formed at a great height in the atmosphere above Barbadoes, and a vast profusion of ashes fell upon the island. This apparent transportation of matter against the wind caused the utmost astonishment amongst the inhabitants, and the certainty of the fact cannot but be considered as of the utmost interest to the science of meteorology.

12. The mean height of the barometer is not affected by the trade winds. This is a proof that the quantity of air which passes below from the poles to the equator, must be exactly balanced by an equal quantity flowing above in the opposite direction. 13. Between the latitudes 30° and 40° both in the northern and southern hemispheres, westerly winds prevail. 14. The western coasts of the extratropical continents have a much higher mean temperature than the eastern coasts. This difference is extremely striking between the western coasts of North America, and the opposite eastern coast of Asia. It is explained by the heat evolved in the condensation of vapour swept from the surface of the ocean by the western winds. This general current in its passage over the land deposits more and more of its aqueous particles, and by the time that *it* arrives upon the eastern coasts is extremely dry; as it moves onwards it bears before it the humid atmosphere of the intermediate seas, and arrives upon the opposite shores in a state of saturation. Great part of the vapour is there at once precipitated, and the temperature of the climate raised by the evolution of its latent heat.

15. A wind generally sets from the sea to the land during the day, and from the land to the sea during the night, especially in hot climates. The land and sea breezes are amongst the most constant of the phenomena of the inconstant subject with which we are occupied; the land becomes much more heated by the action of the sun's rays than the adjacent water; and the incumbent atmosphere is proportionably rarefied; during the day, therefore, the dense air of the ocean rushes to displace that of the land; at night, on the contrary, the deep water cools much more slowly than the land, and the reverse action takes place as these changes proceed gradually. The height of the barometer is not affected by them.

16. The trade winds in the neighbourhood of the western coasts of the large continents, in their course have their direction changed. This is an effect of the same nature as that of the land and sea breezes. Those parts of Africa and America which lie between the tropics, become intensely heated by the action of a vertical sun: the columns of the atmosphere which rest upon them must therefore be highly rarefied, and the more temperate air of the surrounding seas will press upon them. This influence is so decided as to overcome the tendency of the east wind; and on the western coasts of both contitinents a wind from the west prevails. This is again an instance of a complete perpendicular change from a permanent cause, and the total pressure is unaffected. Of the same nature are the monsoons of the Indian ocean, and other periodical winds; they are occasioned by a particular distribution of land and water, acted upon by the periodical changes of the sun's declination. While the sun is vertical to the place where they occur, the land becomes heated, and the air expanded, and the wind flows towards the coasts as the sun retires towards the opposite point of its course; the land cools faster than the surrounding seas, and the course of the wind is westward, the simplest way of regarding the sun's motion in declination, as affecting the temperature of the various latitudes, is to suppose a motion of the whole system; by which the line of greatest heat, and the two points of greatest cold, maintaining their relative distances, vibrate on either side of the earth's equator and poles. None of these changes affect the barometer.

17. Rain seldom occurs in the constant trade-winds, but abundantly and constantly in the adjoining latitudes. Between the tropics the elasticity of the aqueous vapour reaches its maximum amount, and within these limits only, rises to any extent into the upper current of the atmosphere. Its own force which is laterally exerted, is assisted by the equatorial wind, and it flows to the north and south as fast as it rises within the zone; no accumulation can therefore be formed, and the temperature being remarkably steady, seldom varying more than two or three degrees, precipitation can but seldom occur. The continental parts, however, of the same regions being liable to greater vicissitudes of heat, are subject to rainy seasons, which are periodical, like the monsoons of the same climates, and are governed as they are by the progress of the sun in declination. The condensation, while it lasts, is in proportion to the density of the vapours, and is violent beyond any thing that is known in temperate climates. The alternate seasons of fine weather are distinguished by cloudless skies and perfect serenity. The extra tropical latitudes, on the contrary, beyond the bounds of the trade winds, are at all times exposed to great precipitation; the vapour in its course is subjected to a rapidly decreasing temperature, and the condensation is fed by a constant supply. We are thus led to the consideration of a temperate zone and a variable climate.

18. Between the tropics the fluctuations of the barometer do not much exceed ¼ of an inch, while beyond this space they reach to three inches. 19. In the temperate climates the rains and the winds are variable. 20. As we advance towards the polar regions we find the irregularities of the wind increased, and storms and calms repeatedly alternate, without warning or progression. The extremes of heat and cold will sometimes prevail within a very limited compass; and forcible winds will blow in one place, when at the distance of a few leagues gentle breezes prevail. Ships within the circle of the horizon may be seen enduring every variety of wind and weather at the same moment: some under close-reefed top-sails labouring under the force of a storm; some becalmed, and tossing about by the violence of the waves, and others plying under gentle breezes, from quarters as diverse as the cardinal points. The fluctuations of the barometer are also great and sudden, proving that theory would have induced us to conclude that the irregularities of those regions extend to the higher strata of the atmosphere.

21. In the extra tropical climates, a fall in the barometer almost always precedes a fall of rain, and indicates an acceleration or change of the aërial currents. 22. Barometers situated at great distances from each other often rise and fall together with great regularity. 23. More than two currents may often be traced in the atmosphere at one time by the motions of the clouds, &c. 24. The force of the winds does not always decrease as the elevation increases, but on the contrary is often found to augment rapidly. 25. The variations of the barometer are less in high situations than in those at the level of the sea. 26. In Great Britain, upon an average of ten years, westerly winds exceed the easterly in the proportion of 225 to 140. Of those from the east, the northerly exceed the southerly in the proportion of about 74 to 54; leaving but a very small proportion indeed which blow from the most irregular point, *viz.* the south-east.

27. Upon the same average the northerly winds are to the southerly, 192 to 173. 28. Northerly winds almost invariably raise the barometer, while southerly as constantly depress it. 29. The most permanent rains of this climate come from the southern regions. 30. The mean height of the barometer varies but little with the changes of the seasons. 31. The elasticity of the aqueous vapour does not decrease gradually as we ascend in the atmosphere, in proportion to the gradual decrease of the temperature and density of air; but the dew point remains stationary to great heights, and then suddenly falls to a large amount. 32. The tension of vapour given off in the process of evaporation is determined, not by the temperature of the evaporating surface, but by the elasticity of the aqueous atmosphere already existing. 33. The apparent permanency and stationary aspect of a cloud is often an optical deception arising from the solution of moisture on one side of a given point, as it is precipitated on the other. 34. The quantity of vapour in the atmosphere, in the different seasons of the year, (measured on the surface of the earth, and near the level of the sea,) follows the progress of the mean temperature. 35. The pressure of the aqueous atmosphere separated from that of the aërial, generally exhibits changes directly opposite to the latter. 36. Great falls of the barometer are generally accompanied by a temperature above the mean for the season, and great rises by one below the same. That the different phases of the moon have some connexion with changes in the atmosphere, is an opinion so universal and popular, as to be on that account alone entitled to attention. No observation is more general, and on no occa-

sion perhaps is the almanac so frequently consulted, as in forming conjectures upon the state of the weather. The common remark, however, goes no farther than that changes from wet to dry, and from dry to wet, generally happen as the changes of the moon. When to this result of universal experience we add the philosophical reasons for the existence of tides in the aërial ocean, we cannot doubt that such a connexion exists. The subject, however, is involved in much obscurity.

METHOD, from *meta*, beyond, and *odos*, a path, literally means a path from one object to another. "The first idea of *method* is a *progressive transition* from one step in any course to another, and when the word method is used with reference to many such transitions in continuity, it necessarily implies a principle of *unity* with *progression*." "If it be permitted," says Lord Bacon, "to estimate a thing by the importance which is peculiar to it, the science of method may be considered the key of all sciences: in the same manner as the hand is the instrument of instruments, the human intelligence the designer of designs, so method ought to be the art of arts; it not only directs the mind, but strengthens its powers, as the habitual exercise of shooting arrows enables us not only to aim at an object with more precision, but also to bend the bow itself with more vigour." All things in us and about us are a chaos if method be not present, and so long as the mind is entirely passive, so long as there is an habitual submission of the understanding to mere event and images, without any attempt to classify them, so long the chaos must continue. There may be transition, but there can never be progress; there may be sensation, but not thought, for the total want of method renders thinking impracticable. But as soon as the mind becomes accustomed to contemplate not things alone but relation of things, there is immediate need of some path or way of transit from one to the other of the things related;—there must be some law of agreement or of contrast between them; there must be some mode of comparison, in short, there must be *method*.

Method, in Botany, is a mode of arrangement from certain agreements or circumstances of resemblances. There are two kinds of methods in arranging vegetables: the natural method is that which, in its distribution, retains all the natural classes; the artificial method is that, the classes of which are not natural, because they collect together several genera of plants which are not connected by numerous relations, although they agree in the characteristic marks assigned to that class to which they belong.

METHODISTS. The term Methodist was first given to Themison, the founder of a sect of physicians at Rome, which flourished about three hundred years, and had some of the greatest physicians of the age among its members. In the seventeenth century there sprung up a new species of polemic-doctors, who were denominated Methodists, and distinguished themselves by their zeal and dexterity in defending the church of Rome, against the attacks of the Protestants. This sect is now no more; and the appellation is made to designate the followers of the late John and Charles Wesley, and the societies founded by the Rev. George Whitefield. They are divided into Whitefieldian and Wesleyan Methodists. The members of the former division embrace the doctrines of Calvin; the latter, as far as relates to free-will, are Arminians.

METROPOLIS, from *meter*, mother, and *polis*, a city. The chief city of a country.

METON, a celebrated mathematician of Athens, who flourished about 430 years before Christ, and to whom we owe the Metonic *Cycle*.

METONIC Cycle. *See* Cycle.

METONYMY, is a trope in which one name is put for another, on account of the near relation there is between them.

METRE, in Poetry, a system of feet of a just length. The different metres in poetry are the different manners of ordering and combining the quantities, or the long and short syllables; thus, hexameter, pentameter, iambic, sapphic verses, &c. consist of different metres or measures. In English verses the metres are extremely various and arbitrary, every poet being at liberty to introduce any new form that he pleases. The most usual are the heroic, generally consisting of five long and five short syllables, and verses of four feet, and of three feet, and a cæsura, or single syllable. The ancients, by variously combining and transposing their quantities, made a vast variety of different measures, by forming spondees, &c. of different feet.

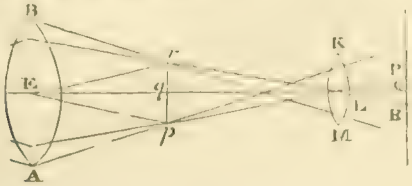
Metre, the base of the new French system of measures.

MEZZOTINTO Scraping, is an art of modern times, that recommends itself to us by the ease with which it is executed, especially by those who understand it. In mezzotinto prints there is no etching, no strokes of the graver are seen; but the lights and shades are blended together, and appear like a drawing in Indian-ink. They are therefore different from aqua tinta; but both resemble Indian-ink, and the difference is not easily pointed out. Mezzotinto is applied to portraits and historical subjects; aqua tinta to landscapes and architecture. The tools for mezzotinto scraping are the grounding tool, burnisher, and scraper, and you proceed by the following rules:—1. To lay the mezzotinto ground, place the plate, with a piece of flannel under it, upon your table, hold the grounding tool in your hand perpendicularly; lean upon it moderately, continually rocking your hand in a right line from end to end, till you have wholly covered the place in one direction: next cross the strokes from side to side, afterwards from corner to corner, working the tool each time over the plate, in every direction, like the points of a compass; taking care not to let the tool cut (in one direction) twice in a place. This done, the plate will be full, or, in other words, all over rough alike, and would, if it were printed, appear completely black. 2. Having laid the ground, take the scrapings of black chalk, and with a piece of rag rub it over the plate; or you may smoke it with candles, as before directed for etching. 3. Now take your drawing, and having rubbed the backs with red-chalk dust, mixed with flake-white, trace it on the plate. 4. To form the lights and shadows, take a blunt needle, mark the outlines only, then with a scraper scrape off the lights in every part of the plate, clean and smooth, in proportion to the strength of the lights in your drawing, taking care not to hurt your outlines. The burnisher is used to soften or rub down the extreme light parts after the scraper has been applied; such as the tip of the nose, forehead, linen, &c. which might otherwise, when proved, appear rather misty than clear. Another method used by mezzotinto scrapers is, to etch the outlines of the original, as also the folds in drapery, making the breadth of the shadows by dots, which having bit to a proper depth with aqua fortis, take off the ground used in etching, and having laid the mezzotinto ground, proceed to scrape as above. When the plate is ready for a proof, have one pulled by the printer. When this proof is dry, touch it with white chalk where it should be lighter, and with black chalk where it should be darker; and when the print is retouched, proceed as before for the lights; and for the dark colours, use, as much as you judge necessary, a small grounding tool, to bring it to a proper colour; and when you have done as much as you think expedient, prove it again; and proceed in this manner to prove and touch, till it is entirely to your mind.

MIASM, or Miasma, from *miaino*, to infect, denotes, among physicians, those atoms or particles which arise from distempered or putrefying poisonous bodies, and which become the contagious effluvia of pestilential diseases, whereby they are communicated to people at a distance.

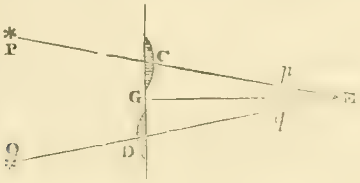
MICA. This stone forms an essential part of many mountains, and has been long known under the names of glacies Mariæ, and Muscovy glass. It consists of a great number of thin laminæ adhering to each other, sometimes of a very large size. Specimens have been found in Siberia nearly 2½ yards square. Its texture is foliated; its fragments flat; the lamellæ flexible, and somewhat elastic; very tough. It has long been employed as a substitute for glass, as it is not so liable to be broken by the agitation of the ship.

MICROMETER, is an instrument fitted to telescopes in the focus of the object-glass, for measuring small angles or distances, as the apparent diameters of the planets, &c. Various forms have been given to this instrument by different authors, and various claims have been urged for the honour of the invention. It seems, however, to belong to Gascoigne, an Englishman, though it is doubtful whether Huygens did not also invent the one which he used, without any knowledge of that of the former. Under all the forms of this instrument, the principle of operation is the same, which is, that it moves a fine wire parallel to itself, in the plane of the picture of an object, formed in the focus of the telescope; and with such accuracy as to measure with the greatest precision its perpendicular distance from a fixed wire in the same plane, by which means the apparent diameters of the planets, and other small angles, are exactly determined. This may be illustrated as follows:—Let a planet be viewed through a telescope, and when the parallel wires are opened to such a distance as to appear to touch exactly the two opposite extremities of the disc of the planet, it is obvious that the perpendicular distance between the wires is then equal to the diameter of the object in the focus of the object-glass.



Let this distance, whose measure is given by the mechanism of the micrometer, be represented by the line $p\,q$; then, since the measure of the focal distance $q$ L may be also known, the ratio of $q$ L to $p\,q$, that is, of radius to the tangent of the angle $q$ L$p$, will give the angle itself by a table of sines and tangents; and this angle is equal to the opposite angle P L Q, which the real diameter of the planet subtends at L or at the naked eye. This is the general principle on which the construction of this instrument depends, and the different forms that have been given to it have been more directed towards an improvement of the mechanism than to any other object, but our limits will not allow of entering into a detail of these constructions, and we shall therefore confine our remarks to a description of the divided object-glass micrometer, as invented by Dollond, and allowed to be the most accurate of any yet discovered.

*Divided Object-Glass* MICROMETER. This instrument consists of a convex lens divided into two equal parts C, D, by a plane which passes through its axis; and the segments are moveable on a graduated line C D, perpendicular to that axis. Let C, D, be the centre of the segments; and P, Q, two remote objects, images of which will be formed in the lines P C E, Q D E, and also in the principal foci of the segments. Let the glasses be moved till these images coincide as at E; then the angle P E Q, which the objects subtend at E the principal focus of C, or D, is equal to the angle which C D, the distance of the centres, subtends at the same point; and therefore, by calculating this angle, we may determine the angular distance of the bodies P and Q, as seen from E. Draw E G perpendicular to C D; and, because the triangle C E D is isosceles, C G = G D, and the ∠ C E G = the ∠ G E D; also, G D is the sine of the angle G E D, to the radius E D; therefore, knowing E D and G D, the angle G E D may be found by the tables; and consequently 2 G E D, or C E D, may be determined. The angle C E D is in general so small, that it may, without sensible error, be considered as proportional to the subtense C D. And being determined in one case by observation, it may be found in any other by a single proportion. If the objects be at a given finite distance, the angle P E Q will still be proportional to CD; for on this supposition, the distance C E, or D E, of either image from the corresponding glass, will be invariable; therefore the angle C E D will be proportional to C D. The divided object-glass is applied both to reflecting and refracting telescopes; and thus small angular distances in the heavens are measured with great accuracy.

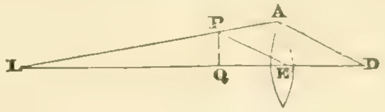


MICROPHONICS, the science of magnifying small sounds.

MICROSCOPE, an instrument for magnifying small objects by means of a proper adjustment and combination of lenses or mirrors. The invention of microscopes, like most other ingenious discoveries, has been claimed for different authors. Huygens informs us, that the first microscopes were constructed by Drebell, a Dutchman, in 1621; but F. Fontana, a Neapolitan. in 1646, claims the invention as his own, which he dates from the year 1618. Microscopes are divided into *single*, *compound*, *reflecting*, *solar*, &c.

*Single* or *Simple* MICROSCOPE, is one which consists of a single lens.

*Theory of Single Microscopes.*—If the angle which subtends at the centre of the eye, when at a proper distance for distinct vision, be less than a certain limit, that is, if it be less than 4′, it will only appear to the eye like a physical point; and if we endeavour to increase the image by bringing it nearer to the eye, the extreme rays will diverge so much as to render the object indistinct; and if the extreme rays be sloped, there will then be too little light to make the object distinctly visible; the microscope is, therefore, introduced in order to supply these defects of natural vision, which is effected by placing the object in the principal focus of a glass spherule or lens, whose focal length is short; in which case it may be distinctly seen, the visual angle, as well as the quantity of light admitted into the eye, being increased, and the parts which before appeared only as a physical point, may now be subjected to examination; the visual angle thus formed, being to that formed at the naked eye, at the least distance of distinct vision, as that distance is to the focal length of the glass.



Let Q P be an object placed in the principal focus of the lens, or spherule A E, whose centre is E; L Q the least distance at which it can be seen distinctly with the naked eye; join L P, P E. Then the angle under which the object is seen through the glass, is equal to P C Q; and the angle under which it is seen with the naked eye, is Q L P. Also, when these angles are small, since they have a common subtense Q P, they are nearly in the inverse ratio of the radii E Q, L Q; that is, the visual angle, when the object is seen through the glass: the visual angle when it is seen with the naked eye at the distance L Q :: L Q : E Q.

*Example.* If the focal length of the glass be $\frac{1}{50}$ of an inch, and at the least distance of distinct vision 8 inches, the visual angle of the object when viewed through the glass : is the visual angle when it is seen with the naked eye :: 8 : $\frac{1}{50}$ :: 400 : 1.

*The Double* or *Compound* MICROSCOPE, consists of two lenses at least, but generally of three, and often more. We shall first describe the one which contains two:—The lens D E. in fig. 1, (plate OPTICS,) is therefore to be overlooked in comparing this description with the figure. The first or smallest lens C is placed near the small object A B, at a little more than its focal distance from it; a large image of the object is thus formed, which will be as much larger than the object, as the distance C L is greater than the distance A C; and as this distance may be made greater or less by placing the object nearer to or farther from the lens C, the image may be increased or diminished at pleasure. And as this image may be distinctly viewed, and still further magnified by a convex lens M N, placed at its focal distance from the image, it is evident that small objects may be thus magnified to many times their real size.* Suppose, for example, that the distance of the object C L is 12 times the distance of the image at CA, then will the length of the image K L be 12 times the length of the object A B, when viewed with the naked eye; but this length of the image, if viewed with an eye-glass of one inch focal distance, will appear six times as large as it does to the naked eye, and therefore its length will appear 12 times 6, or 72 times larger than to the naked eye; and, as its breadth will be magnified in the same proportion, its surface will be 72 times 72, or 5184 times larger than that of the object when viewed with the naked eye. Though the magnifying power of this microscope be very considerable, yet the extent or field of view is very small and confined; therefore, in order to enlarge it, and to increase the quantity of light, another large lens D E, is placed between the two already noticed, (see the figure,) by which means the angle D C E or A C B, under which the visible part of the object appears, may be considerably enlarged; the image will then be formed again at F G, and as the image thus formed is now contained between the two extreme parallel rays of the eye-glass M F and N G, is wholly visible; whereas before, the part O Q could only be seen. But though the object is not quite so much magnified on the whole, in this as in the former case, yet the visible surface is very much increased by the addition of this third glass. The glass R S is a plain mirror, which is employed to reflect the light I, in order to illuminate transparent objects when examined by this instrument.

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* This lens or glass being nearest the eye, is usually called the eye-glass.

*The Solar* MICROSCOPE, invented by Dr. Lieberkhun, is employed to represent very small objects on a very large scale, in a dark room. This is accomplished in the following manner: Let A B, fig. 2, plate OPTICS, represent a beam of the sun's light falling on a small mirror or looking-glass D C, adjusted by two brass wheels to such an inclination as shall reflect the rays which fall upon it parallel to the horizon, to a large convex lens E F, which converges them to a focus; near this focus, as at G H, is placed a small object, which is by this means strongly illuminated, and the rays which flow from it through a small convex lens I, so adjusted by a slider to a little more than its focal distance from the object, produce a very large image K L, which being received upon a white table cloth, or allowed to fall on the opposite wall of the darkened room, will represent the object magnified in proportion to the distance of the picture from the lens I.* Suppose that the small lens I is one-tenth of an inch distant from the object, when the image K L is duly formed on a sheet or table cloth, at the distance of 16 feet from the small lens just mentioned; then in 16 feet there are 192 inches, and consequently 1·920 tenths of an inch; therefore the image is 1,920 times the length of the object, and as many times its breadth; the area or surface of the image is therefore 1,920 times 1,920, or 3,086,400 times that of the object. Such is the prodigious magnifying power of the solar microscope.

*Harris's Improved Botanic* MICROSCOPE.—This compact instrument is found particularly to recommend itself to the practical botanist and naturalist, as a truly able assistant in their researches through the animal, vegetable, and mineral kingdoms, and more especially when its facility of management and portability, combined with its extent of magnifying power, are brought into consideration. To use this microscope, fig. 3, plate OPTICS, take its parts out of the case, unscrew the pillar A on the top, the stage B has a stem which attaches at the socket D. The three lenses at E screw into the arm C, which is fixed by the milled head F; that lens which is dotted thus ... magnifies the least, and the lens . the most; and by screwing into each other, seven different magnifying powers are obtained by combination: W is a yet stronger power than those at E, (which must be removed while W is in use,) being for the purpose of observing objects otherwise too minute to be seen. Transparent objects similar to those in slide Y, are examined by attaching them to the stage B, and by varying the inclinations of the mirror G, (which must be towards the light,) the objects will have more or less light reflected on them, and by adjusting the stage B up or down by the rackwork at H, the objects are seen more or less distinctly. When opaque objects are to be examined, remove the mirror G from its box, and screw the lens ... into the back, then fixing it by its stem to the stage B, the light of a candle is concentrated on the objects; this is useless by day. I is a black and white piece on which opaque objects are placed, and fits the stage B. J is a screw box for confining living objects, and is also to be laid on the stage B. K a pair of steel nippers that attaches to the stage B by its stem, for holding small insects, leaves, or wings, &c. L is a pair of forceps for taking up objects too small for the touch. M and N a dissecting knife and point for separating the smaller parts of flowers, &c. The dotted outlines N represent a body that may screwed on at E, making it an improved Compound Microscope, affording a much larger field of view, and requires a larger case.

MICROSCOPIC OBJECTS, those things which are too small to be seen distinctly by the naked eye.

MIDDLE LATITUDE, is half the sum of two given latitudes when they are both in the same hemisphere, or half their difference if they are in different hemispheres; in which latter case it will always be of the same name as the greater.

MIDWIFERY, in the restricted sense of the word, is the art of assisting women in childbirth. It is generally, however, made to comprehend the management of women, both previously to, and sometime after, delivery; as well as the treatment of the infant in its early state.

MIGRATION OF BIRDS. It has been generally believed, that many different kinds of birds annually pass from one country to another, and spend the summer or the winter where it is most agreeable to them; and that even the birds of our own island will seek the most distant southern regions of Africa, when directed by a peculiar instinct to leave their own country. It has long been an opinion pretty generally received, that swallows reside during the winter season in the warm southern regions; and Mr. Adanson particularly relates his having seen them at Senegal, when they were obliged to leave this country. But besides the swallows, Mr. Pennant enumerates many other birds which migrate from Britain at different times of the year, and are then to be found in other countries; after which they again leave these countries, and return to Britain. The reason of those migrations he supposes to be a defect of food at certain seasons of the year, or the want of a secure asylum from the persecution of man during the time of courtship, incubation, and nutrition.

*Water Fowl.*—Of the vast variety of water fowl that frequent Great Britain, it is amazing to reflect how few are known to breed here: the cause that principally urges them to leave this country seems to be not merely the want of food, but the desire of a secure retreat. Our country is too populous for birds so shy and so timid as the bulk of these are: when great part of our island was a mere waste, a tract of woods and fens, doubtless many species of birds (which at this time migrate) remained in security throughout the year. Egrets, a species of heron, now scarcely known in this island, were in former times in prodigious plenty; and the crane, that has totally forsaken this country, bred familiarly in our marshes; their place of incubation, as well as of all other cloven-footed water fowl, (the heron excepted,) being on the ground, and exposed to every one. As rural economy increased in this country, these animals were more and more disturbed; at length, by a series of alarms, they were necessitated to seek, during the summer, some lonely safe habitation. On the contrary, those that build or lay in the almost inaccessible rocks that impend over the British seas, breed there still in vast numbers, having little to fear from the approach of mankind; the only disturbance they meet, in general, being from the desperate attempts of some few to get their eggs.

MILDEW, is said to be a kind of thick, clammy, sweet juice, exhaled from or falling down upon the leaves and blossoms of plants. By its thickness and clamminess it prevents perspiration, and hinders the growth of the plant. It sometimes rests on the leaves of trees in form of a fatty juice, and sometimes on the ears of corn. It is naturally very tough and viscous, and becomes still more so by the sun's heat exhaling its more fluid parts; by which means the young ears of corn are so daubed over, that they can never arrive at their full growth. Bearded wheat is less subject to the mildew than the common sort; and it is observed, that newly dunged lands are more liable to mildew than others. The best remedy is a smart shower of rain, and immediately afterwards a brisk wind.

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* It is scarcely necessary to remark, that the lenses and object to be viewed are placed in a tube, which is screwed into a hole in the window shutter, or a board placed in the window, which serves at the same time to exclude the light.

If the mildew is seen before the sun has much power, it has been recommended to send two men into the field with a long cord, each holding one end; and drawing this along the field through the ears, the dew will be dislodged from them before the heat of the sun is able to dry it to that viscous state in which it does the mischief. Some also say, that lands which have for many years been subject to mildews, have been cured of it by sowing soot along with the corn, or immediately after it.

**MILE,** (MILLE PASSUS,) a measure of length or distance, containing eight furlongs, &c. *See* MEASURE. The English statute mile is fourscore chains, or 1760 yards; that is, 5280 feet. *See* CHAIN, YARD, AND FOOT. We shall here give a table of the miles in use among the principal nations of Europe, in geometrical paces, 60,000 of which make a degree of the equator.

| | *Geometrical paces,* | | *yards.* |
|---|---|---|---|
| Mile of Russia, | 750 | or | 1100 |
| of Italy, | 1000 | or | 1467 |
| of England, | 1250 | or | 1760 |
| of Scotland and Ireland, | 1500 | or | 2200 |
| The small league, | 2000 | or | 2933 |
| The mean league, | 2500 | or | 3666 |
| The great league of France, | 3000 | or | 4400 |
| Mile of Poland, | 3000 | or | 4400 |
| of Spain, | 3248 | or | 5028 |
| of Germany, | 4000 | or | 5866 |
| of Sweden, | 5000 | or | 7233 |
| of Denmark, | 5000 | or | 7233 |
| of Hungary, | 6000 | or | 8800 |

**MILIARY** FEVER, a malignant fever so called from the eruption of certain pustules resembling millet-seeds.

**MILITARY** TACTICS teach the art of disposing forces in battle array, and performing its proper motions and evolutions. The Greeks, skilful in this part of the military art, had public professors of it, called Tactici, who taught and instructed their youth. Tactics signifies also the art of inventing and making machines for throwing darts, arrows, stones, fire-balls, &c. by means of slings, bows, and counterpoises. Naval tactics instruct us in the arrangement of a fleet for an engagement by sea.

MILITARY *Discipline*, or the training of the soldiers, and the due enforcement of the laws and regulations instituted by authority, may be considered the soul of all armies; unless it be established with prudence, and supported with resolution, assemblies of armed men are little better than a rabble, and more dangerous to a state than its enemies. By the force of discipline, men are kept in obedience to command, in opposition to the impulse of their passions, and make each army, as it were, a complicated, but immense and energetic machine.

*Rank*, is the appointment of officers, or a gradation of authority necessary towards the establishment of discipline and subordination. An army is commanded by a captain-general or commander-in-chief, and general and staff officers. Field-marshals, long disused in the British army, have been revived in the persons of their Royal Highnesses the Duke of York and the Prince of Cobourg; the Duke of Wellington, &c. The rank of commander-in-chief corresponds to the degree of field marshal in the French service. A lieutenant, or even a major-general, has sometimes the appointment of commander-in-chief. When an army is considerable, the following is deemed an adequate staff, exclusive of the commander-in chief: a general for the horse and one for the foot, or a general for each wing of the army; a major-general for every two brigades; and nearly half that number of lieutenant generals. But the duties of all these are much the same; the terms denoting chiefly the gradations of rank. General officers may command any number of men, from a company or troop to several regiments. Generals have no pay, except when employed; but then they have from two to ten pounds a day.

The commander-in-chief, or captain-general, or general, commands all the military of a nation or army; he receives himself his orders from the king, and communicates them to all general officers, who distribute them through all the corps of the army. Colonels command regiments—but there are lieutenant colonels, who are the second officers in regiments, and command in the absence of the colonels. The major-general acts immediately under the general, receiving his orders, and delivering them out to the majors of brigades, with whom he concerts what troops are for duty or guard, detachments, convoys, or foraging parties. The major of a regiment conveys all orders to the regiment after he has drawn them up, sees it march, provides quarters, &c. He is the only officer of an infantry regiment who is allowed a horse in service, to facilitate communications. In a regiment of horse, the major commands in the colonel's absence. A brigadier commands a brigade; and the eldest colonels are usually such as are advanced to this post. Whoever is upon duty is brigadier of the day. He marches at the head of his own brigade, and is allowed a serjeant and ten men of his own brigade, for his guard. The rank of a brigadier general in the British service used to be suppressed in time of peace. Brigadiers, or sub-brigadiers, are posts in the horse-guards. The brigadier, or brigadier-general, appoints an officer called a brigade major, to assist him in all the management of his brigade. Experienced captains are appointed to this post; and act in the brigade as major-generals do in the army, receiving their orders from their commanders.

Captains. A captain-general is he who commands in chief. A captain of a troop, or company, commands a troop of horse, or company of foot, under a colonel. His duty is, to be careful to keep his company full of able-bodied soldiers; to visit their tents or lodgings; to see what is wanting; to pay them well; and keep them neat and clean. He has the power, in his own company, of making sergeants and corporals. In the horse and foot guards, the captains have the rank of colonels. The commissioned officers, subordinate to the captain, are the lieutenants and ensigns, commonly called subaltern officers. These, though their rank is not the same, perform duty together without distinction. Their ordinary duties are, in garrison, guards, detachments, courts martial, the visiting of hospitals and barracks, fatigues on working parties, and orderly duties. And no officer can exchange his duty with another, except by permission of the commanding officer. Thus, the ensign bears the colours, and has charge of them in battle, yet is he under the lieutenant. The adjutant assists the major, and receives his orders nightly from the brigade major; these, after being submitted to the colonel, he delivers to the sergeants. Almost all duties are regulated by the adjutant as major's assistant, as detachments, guards, the charge of ammunition, the prices of bread, beer, &c. The quarter-master is rather a civil than a military officer; and though next to the adjutant, he has nothing to do with the discipline of the regiment. He superintends the clothing, quarters, ammunition, firing, &c. The surgeon, a commissioned officer on the staff of the regiment, requires to be skilled in physic, pharmacy, and anatomy. The chaplain, the last commissioned officer on the staff, is generally allowed to act by deputy when he thinks proper. Serjeant-major, the first, and properly speaking the only non-commissioned officer on the staff, bears the same subordinate relation to the adjutant, as the adjutant does to the commanding officer; and as the adjutant keeps a register of the officers, so does the sergeant-major of the sergeants and corporals, whom he warns in turn for duty, and orders the quota of men each company is to furnish. The sergeant-major attends all parades, to see if the exact number of men are there, and that they are clean and well dressed. He is to make the other sergeants and corporals responsible for neglect in any of those particulars. Sergeants and corporals are also non-commissioned officers, and superintend the private men; the drum major, the drum boys, and the private men, are mighty in their collective force in an army.

**MILIUM,** MILLET, a genus of the digynia order, in the triandria class of plants; and in the natural method ranking under the fourth order, gramina. There are twelve species, of which the most remarkable is the effusum, or common millet.

**MILK,** a well-known fluid, prepared by nature in the breasts of women, and the udders of other animals, for the nourishment of their young. Its contents are of three kinds: 1st. An oily part, which, whatever may be said concerning the origin of other oils in the body, is certainly immediately derived from the oil of the vegetables taken in, as with these it agrees very exactly in its nature, and would entirely, if we could separate it fully from the coagulable part. Another mark of agreement is their separability, which proves that the mixture has been lately attempted, but not fully performed. 2dly. Besides this oily, there is a proper coagulable part: And, 3dly. Much water accompanies both, in which there is dissolved a saline saccharine substance. These three can be got separate in cheese, butter, and whey; but never perfectly so, a part of each being always blended with every other part. Milk by evaporation yields a sweet saline matter, of which Dr. Lewis gives the following proportion:

| Twelve ounces of | Left of dry matter | From which water extracted a sweet saline substance amounting to— |
|---|---|---|
| Cows' milk ....... | 13 drachms. | 1½ drachms. |
| Goats' milk ....... | 12½ ........ | 1½ .... |
| Human milk ..... | 8 ........ | 6 .... |
| Asses' milk ...... | 8 ........ | 6 .... |

The saline substance extracted from asses' milk was white, and sweet as sugar; those of the others brown or yellow, and considerably less sweet; that from cows' milk had the least sweetness of any. On distilling 12 quarts of milk in balneo mariæ, at least 9 quarts of pure phlegm were obtained; the liquor which afterwards arose was acidulous, and by degrees grew sensibly more and more acid as the distillation was continued. After this came over a little spirit, and at last an empyreumatic oil. The remaining solid matter adhered to the bottom of the retort, in the form of elegant shining black flowers, which being calcined and elixated, yielded a portion of fixed alkaline salt. Milk set in a warm place throws up to the surface an unctuous cream, from which, by agitation, the butter is easily separated. The addition of alkaline salts prevents this separation, not (as some have supposed) by absorbing an acid from the milk, but by virtue of their property of intimately uniting oily bodies with watery liquors. Sugar, another grand intermedium betwixt oils and water, has this effect in a greater degree, though that concrete is by no means alkaline, or an absorbent of acids. The sweet saccharine part of the milk remains dissolved in the whey after the separation of the curd or cheesy matter, and may be collected from it in a white crystalline form, by boiling the whey till all remains of the curdled substance have fallen to the bottom; then filtering, evaporating it to a due consistence, setting it to shoot, and purifying the crystals by solution in water and a second crystallization. Much has been said of the medicinal virtues of this sugar of milk, but it does not seem to have any considerable ones: it is from cows' milk that it has been generally prepared; and the crystals obtained from this kind of milk have but little sweetness. New cows' milk, suffered to stand for some days on the leaves of butterwort or sundew, becomes uniformly thick, slippery, and coherent, and of an agreeable sweet taste, without any separation of its parts. Fresh milk added to this, is thickened in the same manner, and this successively. In some parts of Sweden, as we are informed in the Swedish Memoirs, milk is thus prepared for food.

**Milk**, *in the Wine Trade.* The coopers know very well the use of skimmed milk, which makes an innocent and efficacious forcing for the fining down of all white wines, arracks, and small spirits; but it is by no means to be used for red wines, because it discharges their colour. Thus, if a few quarts of well skimmed milk be put into a hogshead of red wine, it will soon precipitate the greater part of the colour, and leave the whole nearly white: and this is of known use in the turning of red wines, when pricked, into white; in which a small degree of acidity is not so much perceived. Milk is, from this quality of discharging colour from wines, of use also to the wine-coopers, for the whitening of wines that have acquired a brown colour from the cask, or from having been hastily boiled before fermenting; for the addition of a little skimmed milk, in these cases, precipitates the brown colour, and leaves the wines almost limpid, or of what they call a water whiteness, which is much coveted abroad in wines as well as in brandies.

**Milk** *of Lime.*—**Milk** *of Sulphur.* The name of milk is given to substances very different from milk properly so called, and which resemble milk only in colour. Such is water in which quicklime has been slaked, which acquires a whiteness from the small particles of the lime being suspended in it, and has hence been called the milk of lime. Such also is the solution of liver of sulphur, when an acid is mixed with it, by which white particles of sulphur are made to float in the liquor.

**Milk** *of Vegetables.* For the same reason that milk of animals may be considered as a true animal emulsion, the emulsive liquors of vegetables may be called vegetable milks. Accordingly, emulsions made with almonds, are commonly called milk of almonds. But besides this vegetable milk, which is in some measure artificial, many plants and trees contain naturally a large quantity of emulsive or milky juices. Such are lettuce, spurge, fig-tree, and the tree which furnishes the elastic American resin. The milky juices obtained from all these vegetables, derive their whiteness from an oily matter mixed and undissolved in a watery or mucilaginous liquor.

**Milk-Thistle.** *Carduus Marianus.*—The young leaves in the spring, cut close to the root with part of the stalks on, are said to be good when boiled.

**MILKY WAY.** *See* Galaxy.

**MILL**, is properly an engine for grinding corn and other substances; but the same term is also used to denote a variety of machines, particularly if the first mover be either wind or water.

*Bark* **Mill**, a mill constructed for the purpose of grinding and preparing bark, till it is fit for the use of a tanner. Bark-mills, like most other mills, are worked sometimes by means of horses, at others by water, and at others by wind. One of the best mills we have seen described for these purposes, is that invented by Mr. Bagnall, of Worsley, in Lancashire: this machine will serve not only to chop bark, to grind, to riddle, and pound it; but to beam or work green hides and skins out of the mastering or drench, and make them ready for the ouse or bark liquor; to beam sheepskins and other skins for the skinner's use; and to scour and take off the bloom from tanned leather, when in the currying state. The nature and connexion of its different parts may be understood from the three following figures, Plate II., Mechanics. Fig. 4, is a horizontal plan of the mill. Fig. 5, longitudinal section of it. Fig. 6, transverse section of it. A, the water-wheel, by which the whole machinery is worked. B, the shafts. C, the pit-wheel, which is fixed on the water-wheel shaft B, and turns the upright shaft E, by the wheel F, and works the cutters and hammer by tapets. D, the spur and bevil-wheel at the top of upright shafts. E, the upright shaft F, the crown-wheel, which works in the pit wheel C. G, the spur-nut to turn the stones I. P, the beam, with knives or cutters fixed at the end, to chop or cut the bark; which bark is to be put upon the cutters or grating *i*, on which the beam is to fall. Q, the tryal that receives the bark from the cutters *i*, and conveys it into the hopper H, by which it descends through the shoe J to the stones I, where it is ground. K, the spout, which receives the bark from the stones, and conveys it into the tryal L; which tryal is wired to sift or dress the bark, as it descends from the stones I. M, the trough to receive the bark that passes through the tryal L. R, the hammer, to crush or bruise the bark that falls into the dish S, which said dish is on the incline, so that the hammer keeps forcing it out of the lower side of the said dish, when bruised. *k*, a trough to receive the dust and moss that passes through the tryal Q. T, the bevil-wheel, that works in the wheel D, which works the beam-knife by a crank V at the end of the shaft *u*. W, the penetrating rod, which leads from the crank V to the start *x*. *x*, the start, which has several holes in it to lengthen or shorten the stroke of the beam-knife. *y*, the shaft, to which the slide rods *h, h*, are fixed by the starts *n, n*. *h*, the slide rod, on which the knife *f* is fixed; which knife is to work the hides, &c. On the knife are two springs *a, a*, to let it have a little play as it makes its stroke backwards and forwards, so that it may not scratch or damage the hides, &c. *z*, is a catch in the slide-rod *h*, which catches on the arch-head *e*; and the said arch-head conveys the knife back without touching the hide, and then falls back to receive the catch again. *l*, the roller to take up the slide-rod *h*, while the hides are shifting on the beam *b* by pulling at the handle *m*. *b*, the beam to work the hides, &c. on. Each beam has four wheels *p, p*, working in a trough road, *g*, *g*, and removed by the levers *c*, *c*. When the knife has worked the hide, &c. sufficiently in one part, the beam is then shifted by the lever *c* as far as is wanted. *d*, a press, at the upper end of the beam, to hold the hide fast on the beam while working. *e*, an arch-head, on which the slide-rod *h* catches. *f*, the knife fixed on the slide rod *h*, to work the hides, &c. *i*, Cutters or grating to receive the bark for chopping. The beam P, with knives or cutters, may either be worked by tapers, as described, or by the bevil-wheel T, with a crank, as V, to cut the same as shears. The knife *f* is fixed at the bottom of the start, which is fixed on the slide-rod *h*; the bottom of the start is split open to admit the knife, the width of one foot; the knife should have a gudgeon at each end, to fix in the open part of the start; and the two springs *a*, *a*, prevent the knife from giving too much way when working; the knife should be one foot long and four or five inches broad. The arch-head *e* will shift nearer to, or further from, the beam *h*, and will be fixed so as to carry the knife back as far as is wanted, or it may be taken away till wanted. The roller *l* is taken up by pulling at the handle *m*, which takes up the slide-rod so high as to give head-room under the beam-knife. The handle may be hung upon a hook for that purpose. The slide-rod will keep running upon the roller all the time the hide is shifting; and when the hide is fixed the knife is put on the beam again by letting it down by the handle *m*. There may be two or more knives at work on one beam at the same time, by having different slide-rods. There should be two beams, so that the workmen could be shifting one hide, &c. while the other was working. The beam must be flat, and a little on the slope. As to the breadth, it does not signify; the broader it is the less shifting of the hides will be wanted, as the lever *c* will shift them as far as the width of the hide, if required. Mr. Bagnall has formed a kind of press *d*, to let down, by a lever, to hold the hide fast on each side of the knife if required, so that it will suffer the knife to make its back stroke without pulling the hide up as it comes back. The slide-rod may be weighted, to cause the knife to lay stress on the hide, &c. according to the kind and condition of the goods to be worked. Hides and skins for the skinner's use are worked in the same way as for the tanners. Scouring of tanned leather for the currier's use will be done on the beam, the same as working green hides. It is only taking the knife away, and fixing a stone in the same manner as the knife by the said joint, and to have a brush fixed to go either before or after the stone. The leather will be better secured this way than by hand, and much sooner. The whole machinery may be worked by water, wind, steam, or any other power. And that part of the machinery which relates to the beaming part of the hides may be fixed to any horse bark-mill, or may be worked by a horse or other power separately.

*Barker's* MILL, is a kind of water-mill, invented by Dr. Barker, which without wheel or trundle performs the operation of grinding corn. This mill is represented in fig. 7, Plate II. of MECHANICS, in which A is a pipe or channel that brings water from a reservoir to the upright tube. The water runs down the tube, and thence into the horizontal trunk C, which has equal arms; and runs out through holes at *d* and *e*, opening on contrary sides near the ends of those arms. These orifices *d*, *e*, have sliders fitted to them, so that their magnitude may be increased or diminished at pleasure. The upright spindle D is fixed in the bottom of the trunk, and screwed to it below by the nut *g*; and is fixed into the trunk by two cross bars *f*: so that, if the tube B and trunk C be turned round, the spindle D will be turned also. The top of the spindle goes square into the rynd of the upper mill-stone H, as in common mills; and as the trunk, tube, and spindle, turn round, the mill-stone is turned round thereby. The lower or quiescent mill-stone is represented by I; and K is the floor on which it rests, in which is the hole L to let the meal run through, and fall down into a trough which may be about M. The hoop or case that goes round the mill-stone rests on the floor K, and supports the hopper, in the common way. The lower end of the spindle turns in a hole in the bridge-tree G F, which supports the mill-stone, tube, spindle, and trunk. This tree is moveable on a pin at *h*, and its other end is supported by an iron rod N fixed into it, the top of the rod going through the first bracket O, and having a screw-nut *o* upon it, above the bracket. By turning this nut forward or backward, the mill-stone is raised or lowered at pleasure. Whilst the tube B is kept full of water from the pipe A, and the water continues to run out from the ends of the trunk; the upper mill-stone H, together with the trunk, tube, and spindle, turn round. But if the holes in the trunk were stopped, no motion would ensue, even though the trunk and tube were full of water. For, if there were no hole in the trunk, the pressure of the water would be equal against all parts of its sides within. But when the water has free egress through the holes, its pressure there is entirely removed: and the pressure against the parts of the sides which are opposite to the holes turns the machine.

Mr. James Rumsey, an American gentleman, has rather improved this machine, by conveying the water from the reservoir, not by a pipe as A D B, in great part of which the spindle turns, but by a pipe which descends from A, without the frame L N, till it reaches as low, or lower, than G; and then to be conveyed by a curvilinear neck and collar from G to *g*, where it enters the arms, as is shewn by the dotted lines at the lower part of the figure. A like improvement was made by M. Segner, a German.

Most of the authors who have attempted to lay down the theory of this mill have fallen into error: the most ingenious theory we have yet seen is by Dr. Gregory, who from a rigid investigation of the *modus operandi*, deduces the following easy practical rules for the construction of this mill:—1. Make each arm of the horizontal tube, from the centre of motion to the centre of the aperture, of any convenient length, not less than $\frac{1}{3}$ of the perpendicular height of the water's surface above these centres. 2. Multiply the length of the arm in feet, by ·61365, and take the square root of the product for the proper time of a revolution in seconds; and adapt the other parts of the machinery to this velocity: or, 3. If the time of a revolution be given, multiply the square of this time by 1·6296 for the proportional length of the arm in feet. 4. Multiply together the breadth, depth, and velocity, per second, of the race, and divide the last product by 14·27 times the square root of the height, for the area of either aperture: or, multiply the continual product of the breadth, depth, and velocity, of the race, by the square root of the height, and by the decimal ·07; the last product, divided by the height, will give the area of the aperture. 5. Multiply the area of either aperture by the height of the head of water, and the product by 55·775 (or 56 lbs.) for the moving force, estimated at the centres of the apertures in pounds avoirdupois. 6. The power and velocity at the apertures may be easily reduced to any part of the machinery, by obvious rules.

*Wind* MILL, as its name imports, is a machine or mill that receives motion from the impulse of the wind. Fig. 1, in the plate represents a windmill, whose internal structure is much the same as a water mill, but the external surface consists of the circular building M N, that contains the machinery; E the extremity of the wind shaft, or chief axis, which is generally inclined from 8 to 15 degrees to the horizon; and E A, E B, E C, E D, are four rectangular frames, upon which sails of cloth of the same form are stretched. At the extremity G of the sails, their surface is inclined to the axis 72°, and at their furthest extremities A D, &c. the inclination of the sail is about 83°. Now when the sails are adjusted to the wind, which happens when the wind blows in the direction of the wind-shaft E, the impulse of the wind upon the oblique sails may be resolved into two forces, one of which acts at right angles to the windshaft, and is therefore employed solely in giving a motion of rotation to the sails and the axis upon which they are fixed. When the mill is used for grinding corn, a crown wheel, fixed to the principal axis E, gives motion to a lantern or trundle, whose axis carries the moveable mill-stone.

*Method of Turning the Sails to the Wind.*—That the wind may act with the greatest efficacy upon the sails, the windshaft must have the same direction as the wind. But as this direction is perpetually changing, some apparatus is necessary for bringing the windshaft and sails into their proper position. This is sometimes effected by supporting the machinery on a strong vertical axis, whose pivot moves in a brass socket firmly fixed into the ground, so that the whole machine, by means of a lever may be made to revolve upon this axis, and be properly adjusted to the direction of the wind. Most wind-mills, however, are furnished with a moveable roof, which revolves upon friction rollers inserted in the fixed kerb of the mill; and the adjustment is effected by the assistance of a simple lever. As both these methods of adjustment require the assistance of men, it would be very desirable that the same effect should be produced solely by the action of the wind. This may be done by fixing a large wooden vane or weather-cock at the extremity of a long horizontal arm which lies in the same vertical plane with the windshaft. By this means, when the surface of the vane, and its distance from the centre of motion, are sufficiently great, a very gentle breeze will exert a sufficient force upon the vane to turn the machinery, and will always bring the sails and windshaft to their proper position. This weather-cock, it is evident, may be applied either to machines which have a moveable roof, or which revolve upon a vertical arbor.

*On the Form and Position of Wind Mill Sails.*—It appears from the investigations of Parent, that a maximum effect will be produced when the sails are inclined 54⅔ degrees to the axis of rotation, or when the angle of weather is 35⅓ degrees.* The angle of inclination assigned by Parent is certainly the most efficacious for giving motion to the sails from a state of rest, and for preventing them from stopping when in motion; but he has not considered that the action of the wind upon a sail at rest is different from its action upon a sail in motion; for since the extremities of the sails move with greater rapidity than the parts nearer the centre, the angle of weather should be greater towards the centre than at the extremity, and should vary with the velocity of each part of the sail. The following table exhibits the angle of inclination and weather which must be given to different parts of the sails.

| Parts of the Radius from the centre of motion at E. | Velocity of the Sail at these distances, or values of c. | Angle made with the axis. | | Angle of Weather. | |
|---|---|---|---|---|---|
| | | *Deg.* | *Min.* | *Deg.* | *Min.* |
| $\frac{1}{6}$ | $\frac{a}{3}$ | 63 | 26 | 26 | 34 |
| $\frac{2}{6}$ | $\frac{2a}{3}$ | 69 | 54 | 20 | 6 |
| $\frac{3}{6}$ or $\frac{1}{2}$ | $a$ | 74 | 19 | 15 | 4 |
| $\frac{4}{6}$ or $\frac{2}{3}$ | $\frac{4a}{3}$ | 77 | 20 | 12 | 40 |
| $\frac{5}{6}$ | $\frac{5a}{3}$ | 79 | 27 | 10 | 33 |
| 1 | $2a$ | 81 | 0 | 9 | 0 |

*Results of Smeaton's Experiments.*—Mr. Smeaton found from a variety of experiments, that the common practice of inclining plane sails from 72° to 75° to the axis, was much more efficacious than the angle assigned by Parent, the effect being as 45 to 31. When the sails were weathered in the Dutch manner, that is, when their surfaces were concave to the wind, and when the angle of inclination increased towards their extremities, they produced a greater effect than when they were weathered either in the common way, or according to Euler's theorem. But when the sails were enlarged at their extremities as represented at $\alpha\beta$, in fig. 2, so that $\alpha\beta$ was one third of the radius E D, and $\alpha$ D to D $\beta$ as 5 to 3, their power was greatest of all, though the surface acted upon by the wind remained the same. If the sails be farther enlarged, the effect is not increased in proportion to the surface; and besides, when the quantity of cloth is great, the machine is much exposed to injury by sudden squalls of wind. In Mr. Smeaton's experiments, the angle of weather varied with the distance from the axis; and it appeared from several trials, that the most efficacious angles were those in the following table.

| Parts of the Radius E A, which is divided into 6 parts. | Angle with the Axis. | Angle of Weather. |
|---|---|---|
| 1 | 72 | 18 |
| 2 | 71 | 19 |
| 3 | 72 | 18 middle |
| 4 | 74 | 16 |
| 5 | 77½ | 12½ |
| 6 | 83 | 7 |

If the radius E D of the sail be 30 feet, then the sail will commence at $\frac{1}{6}$ E D, or 5 feet from the axis, where the angle of inclination will be 72°. At $\frac{2}{6}$ E D, or 10 feet from the axis, the angle will be 71°, and so on.

*On the Effect of Wind Mill Sails.*—The following maxims, deduced by Mr. Smeaton from his experiments, contain the most accurate information upon this subject.

*Maxim* 1. The velocity of wind-mill sails, whether unloaded or loaded, so as to produce a maximum effect, is nearly as the velocity of the wind, their shape and position being the same. 2. The load at the maximum is nearly, but somewhat less than as the square of the velocity of the wind, the shape and position of the sails being the same. 3. The effects of the same sails at a maximum, are nearly, but somewhat less than, as the cubes of the velocity of the wind. 4. The load of the same sails at the maximum is nearly as the squares, and their effects as the cubes, of their number of turns in a given time. 5. When sails are loaded, so as to produce a maximum at a given velocity, and the velocity of the wind increases, the load continuing the same; 1st, The increase of effect, when the increase of the velocity of the wind is small, will be nearly as the square of those velocities; 2dly, When the velocity of the wind is double, the effect will be nearly as 10 : 27½ : But, 3dly, When the velocities compared are more than double of that where the given load produces a maximum, the effects increase nearly in the simple ratio of the velocity of the wind. 6. In sails where the figure and positions are similar, and the velocity of the wind the same, the number of turns in a given time will be reciprocally as the radius or length of the sail. 7. The load at a maximum, that sails of a similar figure and position will overcome at a given distance from the centre of motion, will be as the cube of the radius. 8. The effects of sails of similar figure and position are as the square of the radius. 9. The velocity of the extremities of Dutch sails, as well as of the enlarged sails, in all their usual positions when unloaded, or even loaded to a maximum, are considerably quicker than the velocity of the wind.

A new mode of constructing the sails of windmills has been recently given by Mr. Sutton, and fully described by Mr. Hesleden, of Barton, in a work exclusively devoted to the subject. Mr. Sutton gives his sails the form represented in fig. 4. and makes the angle of weather at the point M, equidistant from A and B, equal to 22° 30′. The inclination of the sail at any other point N of the sail, is an angle whose sine is the distance of that point from the centre of motion A, the radius being the breadth of the sail at that point. Fig. 3. shews the angle at the different points of the sail; and the apparent and absolute breadth of the sail at these points. Mr. Sutton's mode of regulating the velocity of the sails, and of bringing them to a state of rest, is particularly ingenious.

We shall now, therefore, proceed to describe a wind-mill, varying in many respects from the common construction. This mill was invented by James Verrier, of North Curry, in Somersetshire, who received a premium from the Society of Arts, for this useful specimen of his ingenuity. Verrier has contrived a register or regulator, by which the vanes are suffered to yield and give way to the impetus of the wind, when it is too forcible; and when it is too languid, it brings the vanes up to the wind, till its force is sufficient to give the mill a proper degree of velocity; by this contrivance, the wind is justly proportioned to the resistance or number of stones put to work, and the mill less liable to be set on fire, or destroyed by the violence of its motion. The vertical shaft of this mill is also much shorter than usual, in consequence of which the whole building (and especially the floor on which the stones are placed) is considerably stronger, and less liable to vibrate than in the common mills.

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* The *weather* of the sails, is the angle which the surface forms with the plane in which they move, and is equal to the complement of the angle which that surface forms with the axis.

This mill, which has eight quadrant sails, is represented in fig. 5, plate WINDMILLS, where AAA are the three principal posts, 20 feet, 7½ inches long, 22 inches broad at their lower extremities, 18 inches at their upper, and 17 inches thick. The column B is 12 feet 10½ inches long, 19 inches in diameter at its lower extremity, and 16 inches at its upper; it is fixed in the centre of the mill, passes through the first floor E, having its upper end secured by the rails G G. E E E are the girders of the first floor, one of which is only seen, being 8 feet 3 inches long, 11 inches broad, and 9 thick; they are mortised into the principal posts A A A and the column B, and are about 8 feet 3 inches above the ground floor. D D D are three posts, 6 feet 4½ inches long, 9 inches broad, and 6 inches thick; they are mortised into the girders E F of the first and second floor, 2 feet 4 inches distant from the posts, A, &c. F F F are the girders of the second floor, 6 feet long, 11 inches broad, and 9 thick: they are mortised into the posts A, &c. and rest upon the upper ends of the posts D, &c. The three rails G G G are 3 feet 1½ inch long, 7 inches broad, and 3 thick: they are mortised into the posts D and the upper end of the column B, 4 feet 3 inches above the floor to their upper edges. P is one of the arms which support the extremities of the bray-trees; its length is 2 feet 4 inches, its breadth 8 inches, and its thickness 6 inches. I is one of the bray-trees into which the extremity of one of the bridge-trees K is mortised. Each bray-tree is 4 feet 9 inches long, 9½ inches broad, and seven thick; and each bridge-tree is 4 feet 6 inches long, 9 inches broad, and 7 thick, being curved 9 inches from a right line, and furnished with a piece of brass on its upper surface, to receive the under pivot of the mill-stones. L L are two iron screw bolts which raise or depress the fore-ends of the bray-trees. M M M are the three millstones, and N N N the iron spindles, each 9 feet long, on which the upper mill-stones are fixed. O is one of three wallowers which are fixed in the upper ends of the spindles N N N; they are 16 inches in diameter, and each is furnished with 14 trundles. *f* is one of the carriage-rails in which the upper pivot of the spindle turns, and is 4 feet 2 inches long, 7 inches broad, and 4 thick. It turns on an iron bolt at one end, the other end sliding in a bracket fixed to one of the joists, and forms a mortise in which a wedge is driven to set the rail and wallower in or out of its work: *t* is the horizontal spur-wheel that gives motion to the wallowers; it is 5 feet 6 inches diameter, is fixed to the perpendicular shaft T, and has 42 cogs or teeth. The perpendicular shaft T is 9 feet 1 inch long, and 14 inches in diameter, having two iron spindles, the under spindle turns in a brass block let flush into the higher end of the column B, and the upper spindle turns in a brass plate inserted into the lower surface of the carriage rail C. The spur-wheel *r* is fixed on the upper end of the vertical shaft T, and is turned by the crown wheel *v* on the windshaft *e*; it is 3 feet 2 inches in diameter, and is furnished with 15 cogs. The carriage rail C, which is fixed on the sliding kerb z, and supports the upper pivot of the vertical shaft, is 17 feet 2 inches long, 1 foot broad, and 9 inches thick. Y Y Q, is the fixed kerb, 17 feet 3 inches diameter, 14 inches broad, and 10 thick; being mortised into the posts A A A, and fastened with screw bolts. The sliding kerb z is of the same diameter and breadth as the fixed kerb, but its thickness is only 7½ inches. It revolves on 12 friction rollers inserted on the upper surface of the kerb Y Y Q, and has 4 iron half staples Y Y, &c. fastened on its outer edge, the perpendicular arms of which are 10 inches long, 2 inches broad, and 1 inch thick, and embrace the outer edge of the fixed kerb, to prevent the sliding one from being blown off. The capsills X, V, of the mill are 18 feet 9 inches long, 14 inches broad, and 1 foot thick; they are fixed at each end with strong iron screw bolts to the sliding kerb, and to the carriage-rail C. On the right hand of *w* is seen the extremity of a cross rail, which is fixed into the capsils X and V by strong iron bolts; *e* is a bracket 5 feet long, 16 inches in its extreme breadth, and 10 inches thick; it is bushed with a strong brass collar, in which the under spindle of the windshaft turns, and is fixed to the cross rail *w*, with iron screw bolts and nuts; *b* is another bracket 7 feet long, 4 feet broad, and 10 inches thick; it is let into the four ends of the capsils, and that it may embrace the collar of the windshaft, it is divided into two parts, which are fixed together with screw bolts. The windshaft *c* is 15 feet long, 2 feet in diameter at the fore end, and 18 inches at the back end; its pivot at the back end is 6 inches diameter; and the shaft has a hole bored through it to admit an iron rod to pass easily through. The vertical crown wheel *v* is six feet in diameter, having 54 cogs which turn the spur wheel *r*. The bolster *d*, which is 6 feet 3 inches long, 13 inches broad, and 6 thick, is tenoned in the cross rail *w*, directly under the centre of the windshaft, having a brass pulley fixed in a mortise at its fore end. On the upper surface of this bolster is a groove in which the sliding bolt R moves, having a brass stud at its fore end. This sliding bolt is not distinctly seen in the figure, but the round top of the brass stud is visible below the letter *h*; the back end of the iron rod that passes through the windshaft bears against the brass stud. The sliding bolt is 4 feet 9 inches long, 9 inches broad, and 4 inches thick. At its fore end is fixed a line which passes over the brass pulley in the bolster, and appears at *a* with a weight attached to its other end, sufficient to make the sails face the wind that is strong enough to work the number of stones employed; and when the pressure of the wind is more than sufficient, the sails turn on an edge, and press back the sliding bolt, which prevents their going with too great velocity; and whenever the wind abates, the sails by the weight *a* are pressed up to their proper place again. By this apparatus the wind is regulated, and justly proportioned to the resistance or work at any time to be performed; an uniformity of motion is likewise secured, and the mill is far less likely ever to move with so rapid a motion as to risk its destruction.

That the reader may understand how these effects are produced, we have represented, in fig. 6, the iron rod and the arms which bear against the vanes or sails; *a h* is the iron rod which passes through the windshaft *c* in fig. 7; *h* is the extremity which moves in the brass stud that is fixed upon the sliding bolt; *ai*, *ai*, &c. are the cross arms at right angles to *a h*, whose extremities *i*, *i*, similarly marked in fig. 7. bear upon the edges of the vanes. The arms *a i* are 6½ feet long, reckoning from the centre *a*, 1 foot broad at the centre, and 5 inches thick; the eight arms *n*, *n*, &c. that carry the sails are 18½ feet long, their greatest breadth is 1 foot, and their thickness 9 inches, gradually diminishing to their outer ends, where they are only 3 inches in diameter; the inner ends of these arms are mortised into the windshaft. The 4 cardinal sails *m*, *m*, *m*, *m*, are each 13 feet long, 8 feet broad at their outer ends, and 3 feet at their lower extremities; *p*, *p*, &c. are the four assistant sails which have the same dimensions as the cardinal ones, to which they are joined by the line S S S S. The angle of the sail's inclination, when first opposed to the wind, is 45 degrees, and regularly the same from end to end.

It is evident from the preceding description of this machine, that the windshaft *c* moves along with the sails; the vertical crown wheel *v* drives the spur wheel *r*, fixed upon the axis T, which carries also the spur wheel *t*. This wheel impels the three wallowers O, one of which only is seen in the figure; these being fixed upon the spindles N, &c. communicate motion to the turning mill-stones.

Mr. John Bywater, of Nottingham, took out a patent in September, 1804, for a method of clothing and unclothing the sails of windmills while in motion, (provided they are made after the Dutch manner,) by which the mill may be clothed either in whole or in part, in an easy and expeditious manner, by a few revolutions of the sails, whether they are going fast or slow, leaving the surface smooth, even, and regular in breadth from top to bottom; and in like manner the cloth, or any part of it, may be rolled or folded up to the whip at pleasure, by simple and durable machinery. The invention consists in either folding or unfolding the cloths while the sails are in motion, by means of cylinders or rollers of any shape, as long as the sails, with a toothed wheel at one end of each, working either directly or indirectly into two wheels without arms, which are hung so as to turn upon a ring of iron fixed to the shaft-head close behind the back stocks, and which may be alternately stopped; so that the wheels at the ends of the cylinders must directly, or by means of a connexion of wheels called carriers or nuts, work into them, by revolving round them through the power of the wind acting on the sails; so that the cylinders must necessarily turn round, and roll up or fold, or unroll or unfold the cloth which is fastend to them, according to the respective wheel, without arms, which is stopped for that purpose. Such is the general contrivance; a detailed account with figures may be seen in the Repertory of Arts, &c. vol. vi. N. S.

*On Horizontal Wind Mills.*—Various opinions have been entertained respecting the relative advantages of horizontal and vertical wind-mills. Mr. Smeaton, with great justice, gives a decided preference to the latter; but when he asserts that horizontal wind-mills have only $\frac{1}{8}$ or $\frac{1}{10}$ of the power of vertical ones, he certainly forms too low an estimate of their power. Mr. Beatson, on the contrary, who has received a patent for the construction of a new horizontal wind-mill, seems to be prejudiced in their favour, and greatly exaggerates their comparative value. From an impartial investigation, it will probably appear, that the truth lies between these two opposite opinions; but before entering on this discussion, we must first consider the nature and form of horizontal wind-mills.

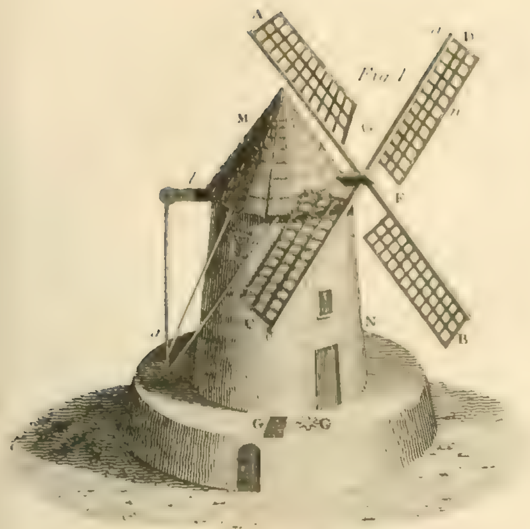
In fig. 4, C K is the windshaft, which moves upon pivots. Four cross bars, C A, C D, I B, F G, are fixed to this arbour, which carry the frames A P I B, D E F G. The sails A I, E G, are stretched upon these frames, and are carried round the axis C K, by the perpendicular impulse of the wind. Upon the axis C K, a toothed wheel is fixed, which gives motion to the particular machinery that is employed. In the figure only two sails are represented; but there are always other two placed at right angles to these. Now, let the sails be exposed to the wind, and it will be evident that no motion will ensue; for the force of the wind upon the sail A I, is counteracted by an equal and opposite force upon the sail E G. In order, then, that the wind may communicate motion to the machine, the force upon the returning sail E G must either be removed by screening it from the wind, or diminished by making it present a less surface when returning against the wind. The first of these methods is adopted in Tartary, and in some provinces of Spain; but is objected to by Mr. Beatson, from the inconvenience and expense of the machinery and attendance requisite for turning the screens into their proper positions. Notwithstanding this objection, however, Mr. Beatson thinks that this is the best method of diminishing the action of the wind upon the returning sails, for the moveable screen may easily be made to follow the direction of the wind, and assume its proper position, by means of a large wooden weathercock, without the aid either of men or machinery. It is true, indeed, that the resistance of the air in the returning sails is not completely removed; but it is at least as much diminished as it can be by any method hitherto proposed. Besides, when this plan is resorted to, there is no occasion for any moveable flaps and hinges, which must add greatly to the expense of every other method.

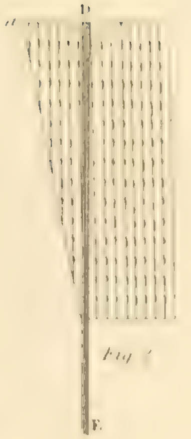
The mode of bringing the sails back against the wind, which Mr. Beatson invented, is perhaps the simplest and best of the kind. He makes each sail A I to consist of six or eight flaps or vanes, A P *b* 1, *b* 1 *c* 2, &c. moving upon hinges represented by the dark lines, A P, *b* 1, *c* 2, &c. so that the lower side *b* 1, of the first flap overlaps the hinge or higher side of the second flap, and so on. When the wind, therefore, acts upon the sail A I, each flap will press upon the hinge of the one immediately below it, and the whole surface of the sail will be exposed to its action. But when the sail A I returns against the wind, the flaps will revolve round upon their hinges, and present only their edges to the wind, as is represented at E G, so that the resistance occasioned by the return of the sail must not be diminished, and the motion will be continued by the great superiority of force exerted upon the sails in the position A I. In computing the force of the wind upon the sail A I, and the resistance opposed to it by the edges of the flaps in E G, Mr. Beatson finds, that when the pressure upon the former is 1872 pounds, the resistance opposed by the latter is only about 36 pounds, or $\frac{1}{52}$ part of the whole force; but he neglects the action of the wind upon the arms CA, &c. and the frames which carry the sails, because they expose the same surface in the position A I, as in the position E G. The omission, however, has a tendency to mislead us in the present case, as we shall now see, for we ought to compare the whole force exerted upon the arms, as well as the sail, with the whole resistance which these arms and the edges of the flaps oppose to the motion of the windmill. By inspecting fig. 4, it will appear, that if the force upon the edges of the flaps, which M. Beatson supposed to be 12 in number, amounts to 36 pounds, the force spent upon the bars C D, D G, G F, F E, &c. cannot be less than 60 pounds. Now, since these bars are acted upon with an equal force, when the sails have the position A I, $1872 + 60 = 1932$ will be the force exerted upon the sail A I, and its appendages, while the opposite force upon the bars and edges of the flaps when returning against the wind will be $36 + 60 = 96$ pounds, which is nearly $\frac{1}{20}$ of 1932, instead of $\frac{1}{52}$ as computed by Mr. Beatson. Hence we may see the probable advantages of a screen over moveable flaps, as it will preserve not only the sails, but the arms and the frame which support it, from the action of the wind.

We shall now conclude this article with a comparison of the power of horizontal and vertical wind-mills. Mr. Smeaton rather underrated the former, while he maintained that they have only $\frac{1}{8}$ or $\frac{1}{10}$ the power of the latter. He observes, that when the vanes of a horizontal and vertical mill are of the same dimensions, the power of the latter is four times that of the former, because, in the first case, only one sail is acted upon at once, while in the second case all the four receive the impulse of the wind. This, however, is not strictly true, since the vertical sails are all oblique to the direction of the wind. This calculation proceeds upon a supposition, that the whole force exerted upon vertical sails is employed in turning them round the axis of motion; whereas a considerable part of this force is lost in pressing the pivot of the axis or windshaft against its gudgeon. Mr. Smeaton has overlooked this circumstance, otherwise he could never have maintained that the power of four vertical sails was quadruple the power of one horizontal sail, the dimensions of each being the same. Taking this circumstance into the account, we cannot be far wrong in saying, that in theory at least, if not in practice, the power of a horizontal wind-mill is about $\frac{1}{3}$ or $\frac{1}{4}$ of the power of a vertical one, when the quantity of surface and the form of the sails are the same, and when every part of the horizontal sails has the same distance from the axis of motion as the corresponding parts of the vertical sails. But if the horizontal sails have the position A I, E G, in fig. 4, instead of the position C A *d m*, C D *o n*, their power will be greatly increased, though the quantity of surface is the same, because the part C P 3 *m* being transferred to B I 3 *d*, has much more power to turn the sails.

*Smeaton's Machine for Experiments on Wind Mill Sails.*—In the experiments with this machine, the sails were carried round in the circumference of a circle, so that the same effect was produced as if the wind had struck the sails at rest with the velocity which was then given them. In the pyramidal frame, fig. 7, A B C is fixed the axis D E, which carries the arm F G with the sails G I. By pulling the rope Z, which coils round the barrel H, a motion of rotation is given to the sails, so that they revolve in the circumference of a circle, whose radius is D I. At L is fixed a cord which passes round the pulleys M, N, O, and coils round a small cylinder on the axis of the sails, and raises the scale C, in which the different weights are placed for trying the power of the sails, and which being in the direction of the axis D E, is not affected by the circular motion of the arm D G. The scale C is kept steady by the pillars Q, R, and prevented from swinging by the chains S, T, which hang loosely round the pillars. V X is a pendulum composed of two leaden balls moveable upon a wooden rod, so that they can be adjusted to vibrate in any given time. The pendulum hangs upon a cylindrical wire, on which it vibrates as on a rolling axis.

*Canicular* MILL *for Grinding Indigo*, &c.; so named because a dog is the first mover. In many parts of Scotland the country dyers use this machine, as exhibited in fig. 8, plate WINDMILLS,


A
a
D
Fig 1
M
l
G
F
C
N
B
G
G


a
D
Fig 2
E

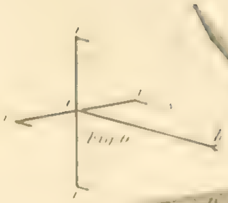


Fig 6
h

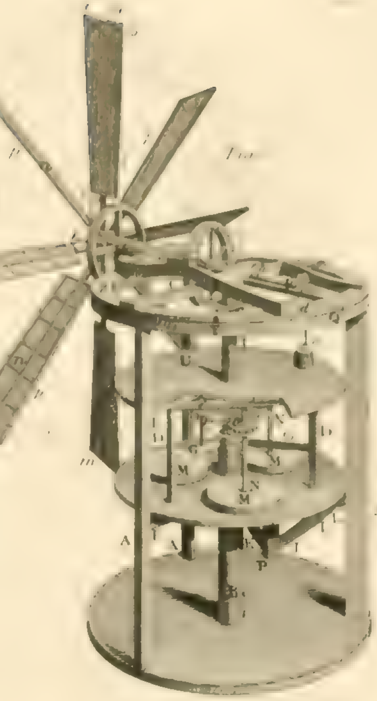
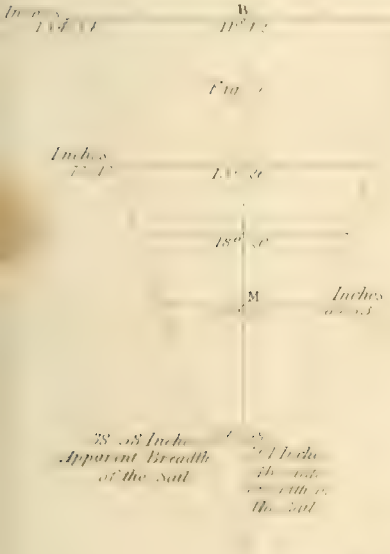
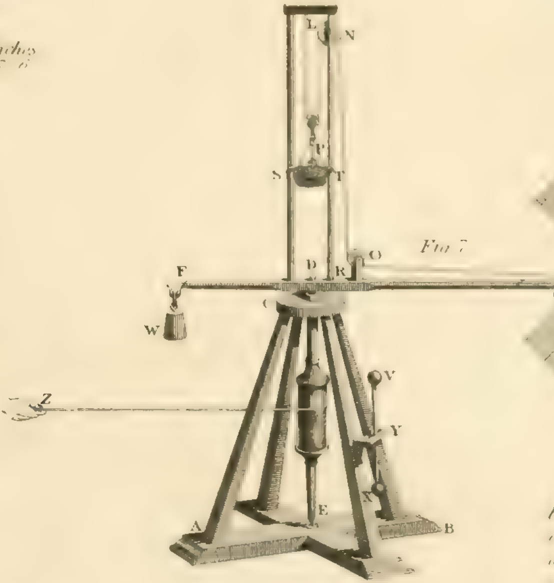
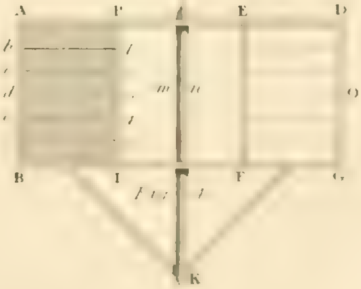
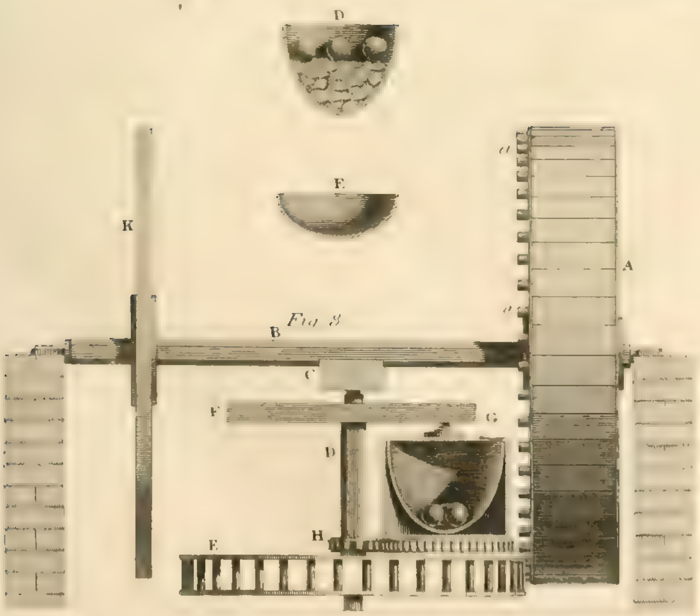


Fig
Q
U
D
G
M
M
N
M
A
A
E
P
B
A


Inches
B
Inches
Fig 3
Inches
18
M
Inches
28 58 Inches
Apparent Breadth
of the Sail


L
N
P
S
T
Fig 7
O
F
D
R
C
W
Z
V
Y
E
A
B


A
P
C
E
D
b
l
m
n
d
O
B
I
F
G
Fig 4
K


D
E
K
a
A
a
Fig 8
B
C
F
G
D
H
E

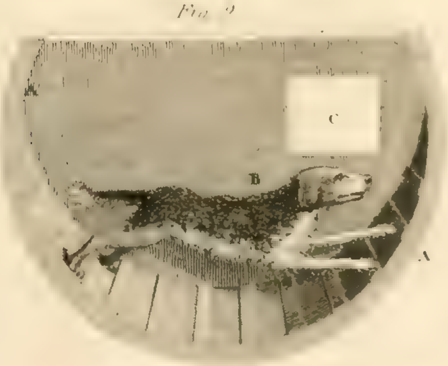


Fig 9
C
B
A

which is a side elevation or profile of the whole machine. A is the walking or canicular wheel, about 21 feet diameter, in which the patient dog walks or runs, producing by means of the equalizing action of the fly wheel K, fixed at the extremity of the shaft, an uniform velocity of from 3 to 6 miles per hour. C is a cross-beam, in which, and a corresponding piece in the floor, works the perpendicular shaft D, on which shaft is fixed the lantern E, driven by the wheel *e*, *e*, set on the inner face of the walking wheel; H, a pinion set on the shaft D; F, a horizontal arm fixed to the shaft D, and in one extremity of which, and the opposite point in the upper cover of the lantern E, the box G is set on pivots; L, an iron vessel, placed within the box, and containing the materials to be pulverized, together with three 18 lb. iron shots; I is a wheel under the bottom of the box G, driven by the pinion H. The action of the machine will now be readily understood. E is driven by the action of the first mover; H, set on the same shaft will drive I, giving G and the vessel L a horizontal motion on its pivots, while E carries it horizontally about the shaft D; the compound motion then produced will effect the operation of grinding, by the centrifugal motion of the balls.

Fig. 9 is a portion of the wheel A, seen in profile, or in front elevation, and having one of its sides taken off to exhibit the action of the dog at B; C is an aperture in any part of one side, for the ingress and egress of the animal; D shews the situations of the balls when the machine is in action; E is inserted to afford the opportunity of explaining, that the figure of the vessel L must be varied with the required rate of motion. If the velocity be reduced, either by the circumstances of the material, or the incapacity of the animal, the vessel must assume a flatter figure, as E; if the velocity be increased, the vessel must be deeper, in proportion to its width.

*Rustall's Family* MILL cannot but be highly useful in the country, and we shall here describe the *Family Mill* and *Bolter* of Mr. Rustall, of Purbrook-heath, near Portsmouth, for which he received a premium of 40 guineas from the Society of Arts.

In plate MANGLE, &c. fig. 10, A is the handle of the mill; B one of the millstones, which is about 30 in. in diameter, and 5 in. in thickness, moving with its axis C; D is the other millstone, which, when in use, is stationary, but which may be placed near to, or at a distance from, the moveable stone B, by means of three screws passing through the wooden block E, that supports one end of the axis C; after it has been put through a hole or perforation in the bed stone. The grain likewise passes through this perforation from the hopper F, into the mill. F represents the hopper, which is agitated by two iron pins on the axis C, that alternately raise the vessel containing the grain, which again sinks by its own weight. In consequence of this motion, the corn is conveyed through a spout that passes from such hopper into the centre of the mill behind, and through the bedstone D. G, a paddle regulating the quantity of corn to be delivered to the mill; and, by raising or lowering which, a larger or smaller proportion of grain may be furnished; H, the receptacle for the flour, into which it falls from the millstones, when ground; I represents one of the two wooden supporters on which the bedstone D rests. These are screwed to the block E, and likewise mortised into the lower framework of the mill at K, which is connected by means of the pins or wedges L, L, L, that admit the whole mill to be easily taken to pieces; M, a fly wheel, placed at the furthest extremity of the axis C, and on which another handle may be occasionally fixed; N, a small rail, serving to keep the hopper in its place; the furthest part of such hopper resting on a small pin, which admits of sufficient motion for that vessel to shake forward the corn; O, a spur rail, for strengthening the framework of the mill; P, the front upright that is mortised into the framework, and serves as a rest for the end of the iron axis C, which is next to the handle. Lastly, there is a cloth hood fixed to a broad wooden hoop, which is placed over the stones while working, to prevent the finer particles of flour from escaping.

The bolter is here represented with its front removed, in order to display its interior structure; the machine being 3 feet 10 inches in length, 19½ inches in breadth, and 18 inches in depth. A is a moveable partition, sliding about 4 feet backwards or forwards, from the centre of the box, upon two wooden ribs, which are fixed to the back and front of the box, and one of which is delineated at the letter B; C, the lid of the bolter, represented open; D, a slider, which is moveable in a groove made in the lid, by means of two handles on the back of such lid; E, a forked iron fixed in the slider D, and which, when the lid is shut, takes hold of the edge of the sieve F, and moves it backwards and forwards on the wooden ribs B, according to the agitation of the slider; G represents a fixed partition in the lower centre of the box, which it divides into two parts, in order to separate the fine from the coarse flour · from this partition the slider A moves each way about four inches, and thus affords room for working the sieve; H, a board that is parallel to the bottom of the bolter, and forms part of the slider A; this board serves to prevent any of the sifted matter from falling into the other partition; I represents two of the back feet, which support the bolter.

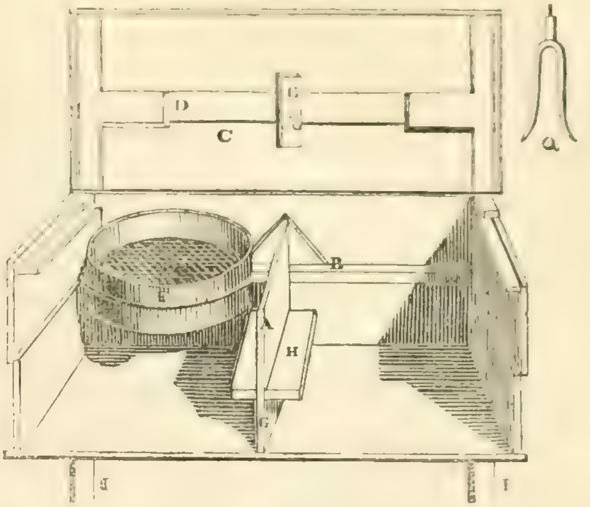


Fig. 11 of the plate above mentioned, is a view of the top, or upper part, of the lid of the bolter; K, the slider that moves the lengthwise of the bolter; L, L, the handles by which the slider is worked; M, a screw serving to hold the fork, which imparts motion to the sieve.

Q represents the forked iron E separately from the lid. Both the mill and bolter may be constructed at a moderate expense. The former may be worked even in a public kitchen, or within a room in a farm house, without occasioning any great incumbrance. The particular excellence of the mill consists in this circumstance, that, from the vertical position of its stones, it may be put in action without the intervention of cogs or wheels. It may be adapted to the grinding of malt, the bruising of oats for horses, and for making flour, or for all these purposes. Another advantage peculiar to Mr. Rustall's contrivance is, that one man is sufficient to work it; though a man and a boy will be able to produce, in two hours, a quantity of flour sufficient to serve a family of six or eight persons, for a whole week;—repeated trials have proved, that the mill grinds the corn completely, and at the rate of one bushel of wheat within the hour.

*Improved Gunpowder* MILL, *for lessening the destructive effects of Explosion*, by Mr. Monk, manager of the gunpowder mills of Messrs. Burton, near Tunbridge, a model and description of which were presented to the Society of Arts in 1819, who voted the inventor its silver medal, and 20 guineas.

In plate MANGLES, fig. 12, *a a* is a compound lever formed of two iron bars, the extremities of which terminate above the bedstones of the pair of mills A B; these levers are connected at their other extremities by a bolt at *b*, forming a joint, and permitting the levers to move so as to form a very obtuse angle, when a power from below upwards is applied to either of the ends of the levers *a a*, as shewn by the dotted lines. *c c*, are two oblong holes in the lever bars, through which two screws are put, which being screwed into the two uprights, constitute the two fixed fulcrums of the lever. *d d*, are two uprights, with an eye or loop in each, to receive and steady the ends of the lever, which are made long enough to allow the bars to take the position indicated by the dotted lines. *e e*, are two blowers made of thin sheet iron, in the form of hollow three-sided pyramids, and are suspended by two iron rods to the ends of the levers *a a*. These blowers are placed as near as possible to the tops of the upright stone shafts, and as close to the wheels as the timber will allow. *f f*, are two copper chains, attached by one end to the lever bars, and by the other supporting two copper valves which are not seen in fig. 1, being inside the tubs, but one of them is shewn at *g*, in the section of a tub, fig. 2. *h h*, are two oval tubs capable of holding about six gallons of water, having a circular hole at the bottom. Surrounding this hole is a grooved block having a channel all round it, into which the bottom edges of the cylindrical valves fit, shewn in section at fig. 2. *i i*, are two small spring catches fastened to the two uprights. The lever bars are laid on the top of these catches, so that when the ends of the lever rise, that part of the lever which is on the catch moves downward, as shewn by the dotted lines, till it slips over the end of the catch; and thus the lever is prevented from resuming its horizontal position, till released from the catch.

In order to fit that part of the apparatus above described for action, bring the lever to a horizontal position, place the valve *g* in the circular channel at the bottom of the tub so as to cover the hole; fill the channel with mercury, and then fill the tub with water. Hence it is evident, that the water is prevented by the mercury from escaping out of the tub, so long as the valve remains in its place. Now, if an explosion happen in either of the mills, the blower *e* hanging over the bedstone, will be thrown up, and the lever will in consequence be brought into the position indicated by the dotted line, and will be retained there by the spring catches *i i;* at the same time the valves *g* will be drawn up out of the mercury, and the water in both the tubs will pour down on their respective bedstones, extinguishing in one the inflamed powder, and in the other preventing it from taking fire. In a certain stage of the grinding the materials of the powder are apt to clot, and adhere to the runners; parts of the bedstones are thus left bare, and the runner and bedstone coming in contact, an accidental spark may be elicited, and an explosion ensue. To prevent this most usual cause of accidents, Mr. Monk fixes to the axle of the wheel a scraper, formed of a curved piece of wood *k*, shod with copper, which being placed behind, and almost touching each of the runners, scrapes off the powder as it collects, and thus keeps the bedstone always covered.

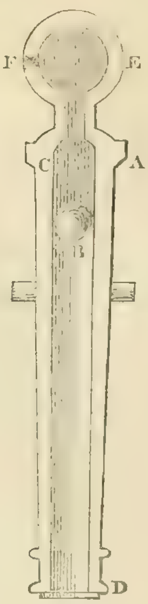
*l*, is the great water wheel which gives motion to the rest. *m m*, are two vertical bevil wheels fixed on the axis of the great wheel. *n n*, two horizontal bevil wheels working in *m m*, and turning the vertical shafts, upon the upper part of which are also fixed two horizontal wheels *o o*, which drive the wheels *p p*. To the shafts of these latter wheels are fixed the runners *q q q*, which traverse on the bedstones *u u*. *v, v*, are the curbs surrounding the bedstone, to prevent the powder from falling off.

The Mill A presents a view, and the mill B a section of the bedstone and curb.

Fig. 2 shews the position of the apparatus after an explosion has taken place, the valve being raised up out of the channel, and the water pouring down on the bedstone.

It appears by several certificates, that since these improved mills have been constructed by Mr. Monk, occasional explosions have taken place, which before generally took place under both pair of stones; but since that time, by the effect of instantaneously wetting the powder under the contrary pair of stones, to those where explosion had taken place, a double disaster has been prevented; and in the short space of three years, in a single manufacturing establishment, eight mills have been saved from destruction, and probably many lives.

*Pasley's Proposal for increasing the Strength of Gunpowder.*—In the annexed figure A D is a longitudinal section of a great gun; C the cartridge; B the ball; E a hollow metal sphere, similar to a bomb-shell or hand-grenade, with a hollow neck or tube G, which screws into the breech of the gun; F the touch-hole. The design is, that the ignited powder in the shell shall throw a quantity of flame suddenly into the gun, and explode every grain of the cartridge powder. It is not, however, meant that preventing any of the powder from being blown out unignited, is to give the additional force; on the contrary, it is certain that the expansive power of explosive mixtures is as the quantity of flame suddenly formed by them, particularly in confined situations, where the flame is supplied with matter from the combustible substance itself only. In proof of this, let flame be communicated to the powder of a charged gun, by firing a pistol containing powder only in its touch-hole, and the result will be found to be, that the momentum of the ball from the gun will be much greater than if the same quantity of powder as that fired from the pistol had been added to the cartridge in the gun, and the whole exploded in the customary manner. This was ascertained by experiment nearly ten years since. The thing is now put beyond all manner of doubt, from the discharge of guns being effected by detonating copper caps. Sportsmen using the same declare, that a less quantity of powder produces an equal effect to a greater quantity without these caps. It may be necessary to add, that trials are indispensable to ascertain the maximum of the size of the shell E, and of the quantity of powder it should contain to be safe and most efficient.—*Query.* Might not the guns of forts be constructed so as to slide backwards and forwards on *fixed* but *centered* carriages, by which much fatigue would be avoided by the men? *See* GUNPOWDER.



MILLS, *Horse* and *Hand.* These machines derive their action from animal force. In horse-mills, one, two, or more horses, or other cattle, are made either to draw, or push before them levers, which project from a centre shaft bearing the great horizontal wheel that gives motion to the more remote parts, and which act with more or less effect, according to the length of the levers and the number of cattle employed.

MILLS, *Oil*, are very simple in their construction; they being nearly the same as cider-mills; consisting of troughs wherein the seed is broken by the passage of immense cylinders, or cones, of iron or stone, and afterwards put into presses for the purpose of forcing the oil from the residuum. *See* OIL MILL.

MILLS, *Copper* and *Brass*, are almost invariably worked by water, having large wheels that give immediate action to hammers of great weight; these beat out the large slabs and bricks of metal into various forms, such as kettles, coppers, boilers, &c. and roll out sheets for various purposes, but especially for coppering the bottoms of ships. This process is effected by passing the heated metal between two cast-iron cylinders, of about a foot diameter, which having contrary motions, draw it through a small interval left between them; and by reducing the thickness, give greater surface to the sheet.

MILLS, *Silk*, *Cotton*, *&c.* require much delicacy in their construction; their principal movements depend on the same principles as those of the mills described: the more minute parts, such as the bobbins, &c. being moved by means of one or more leather straps passing them in close contact, so as to occasion them to revolve with an astonishing degree of velocity. *See* SPINNING.

MILLS, *Saw*, though extremely simple in their parts, require the greatest care in their formation. The saws, which are moved by cranks, must be set with most scrupulous exactness. In most instances the timber is brought forward to the saw by means of a small toothed wheel, and an axle whereon the rope that pulls the timber is gradually coiled. *See* SAW.

MILLS, *Flax*, are generally worked by cattle; their construction is simple; the essential parts being the hackle, which combs the flax; and the scutcher, which strikes it: both tend to clearing away the coarser and unequal fibres, and to prepare the material for being spun either by hand or by means of machinery. *See* FLAX and HEMP.

**MILLENARIANS**, or *Chiliasts*, a name given to those who, in the primitive ages, believed that the saints will one day reign on earth with Jesus Christ a thousand years.

**MILLION**, in Numeration, is one thousand thousands, or 1,000,000. *See* NUMERATION.

**MILLREE**, a Portuguese gold coin, value *5s. 7¼d.* English.

**MILT**, in Anatomy, a popular name for the spleen.

MILT, or *Melt*, in Natural History, the soft roe in fishes; thus called from its yielding, by expression, a whitish juice resembling milk. *See* ROE. The milt is properly the seed or spermatic part of the male fish. The milt of a carp is reckoned a choice bit. It consists of two long whitish irregular bodies, each included in a very thin fine membrane. M. Petit considered them as the testicles of the fish wherein the seed is preserved; the lower part next the anus, he supposes to be the vesiculæ seminales.

**MIMOSA**, the *Sensitive Plant*, a genus of the polygamia order, in the monœcia class of plants, and in the natural method ranking under the 33d order Tomentaceæ. The name mimosa, signifies "mimic;" and is given to this genus on account of the sensibility of the leaves, which, by their motion, mimic or imitate the motion of animals. This genus comprises 85 different species, all natives of warm climates. The sensitive kinds are exceedingly curious plants, in the very singular circumstance of their leaves receding rapidly from the touch, and running up close together; and in some sorts, even the foot-stalks are affected, so as instantly to fall downwards as if held by hinges, which last are called humble sensitives. They have all winged leaves, each wing consisting of many small pinnæ.

"Naturalists," says Dr. Darwin, "have not explained the immediate cause of the collapsing of the sensitive plant; the leaves meet and close in the night during the sleep of the plant, or when exposed to much cold in the day-time, in the same manner as when they are affected by external violence, folding their upper surfaces together, and in part over each other like scales or tiles, so as to expose as little of the upper surface as may be to the air; but do not, indeed, collapse quite so far, for when touched in the night during their sleep, they fall still further; especially when touched on the foot-stalks between the stems and the leaflets, which seems to be their most sensitive or irritable part. Now, as their situation after being exposed to external violence resembles their sleep, but with a greater degree of collapse, may it not be owing to a numbness or paralysis consequent to too violent irritation, like the faintings of animals from pain or fatigue? A sensitive plant being kept in a dark room till some hours after day-break, its leaves and leaf-staks were collapsed as in its most profound sleep, and on exposing it to the light, above twenty minutes passed before the plant was thoroughly awake, and had quite expanded itself. During the night the upper surfaces of the leaves are oppressed; this would seem to shew that the office of this surface of the leaf was to expose the fluids of the plant to the light as well as to the air." The common sensitive humble plant rises with an under shrubby prickly stem, branching six or eight feet high, armed with crooked spines; conjugated, pinnated leaves, with bijugated partial lobes or wings, having the inner ones the least, each leaf on a long foot-stalk; and at the sides and ends of the branches many purple flowers in roundish heads; succeeded by broad, flat, jointed pods, in radiated clusters. This is somewhat of the humble sensitive kind: the leaves, foot-stalks and all, receding from the touch, though not with such facility as in some of the following sorts. The bashful humble plant rises with an under shrubby, prickly stem, branching two or three feet round, armed with hairy spines: by the least touch the leaves instantly recede, contract, close, and, together with the foot-stalk, quickly decline downward, as if ashamed at the approach of the hand. M. scandens, cacoons, or mafootoo wyth, is frequent in all the upland valleys and woodlands on the north side of Jamaica. It climbs up the tallest trees, and spreads itself in every direction, by means of cirrhi, or claspers, so as to form a complete arbour, and to cover the space of an English acre from one root. The pod is perhaps the largest and longest in the world; being sometimes eight or nine feet in length, five inches broad, jointed, and containing ten or fifteen seeds. M. catechu, according to M. Ker, grows only twelve feet in height, and to one foot in diameter. From this tree, which grows plentifully on the mountainous parts of Indostan, where it flowers in June, is produced the officinal drug long known in Europe by the name of terra japonica. The true Egyptian acacia rises to a greater height than the preceding. The fruit is a long pod resembling that of the lupin, and contains many flattish brown seeds. It is a native of Arabia and Egypt, and flowers in July. Although the mimosa nilotica grows in great abundance over the vast extent of Africa, yet gum arabic is produced chiefly by those trees which are situated near the equatorial regions; and we are told that in Lower Egypt the solar heat is never sufficiently intense for this purpose. The gum exudes in a liquid state from the bark of the trunk and branches of the tree, in a similar manner to the gum which is often produced upon the cherry trees, &c. in this country; and by exposure to the air it soon acquires solidity and hardness.

**MINA**, in Grecian Antiquity, a money of account, equal to a hundred drachms.

**MINE**, in Natural History, a place under ground, where metals, minerals, or even precious stones, are dug up. As, therefore, the matter dug out of mines is various, the mines themselves acquire various denominations, as gold mines, silver mines, copper mines, iron-mines, diamond mines, salt mines, mines of antimony, of alum, &c. Mines, then, in general, are veins or cavities within the earth, whose sides receding from, or approaching nearer to, each other, make them of unequal breadths in different places, sometimes forming larger spaces which are called holes, they are filled with substances, which, whether metallic or of any other nature, are called the lodes; when the substances forming these lodes are reducible to metal, the lodes are by the miners said to be alive; otherwise they are called dead lodes. In Cornwall and Devon, the lodes generally hold their course from eastward to westward; though in other parts of England they frequently run from north to south. The sides of the lode never bear in a perpendicular, but constantly under-lay, either to the north or to the south. The lode is frequently intercepted by the crossing of a vein of earth, or stone, or some different metallic substance, in which case it generally happens that one part of the lode is moved a considerable distance to one side. This transient lode is by the miners called flooking; and the part of the lode which is to be moved is said to be heaved. According to Dr. Nichol's observations upon mines, they seem to be, or to have been, the channels through which the waters pass within the earth, and, like rivers, have their small branches opening into them in all directions. Most mines have streams of water running through them; and when they are found dry, it seems to be owing to the waters having changed their course, as being obliged to it, either because the load has stopped up the ancient passages, or that some new and more easy ones are made. Many mines have been discovered by accident; a torrent first laid open a rich vein of the silver mine at Friburg in Germany; sometimes a violent wind, by blowing up trees, or overturning the parts of rocks, has discovered a mine; the same has happened by violent showers, earthquakes, thunder, the firing of woods, or even the stroke of a ploughshare or horse's hoof. The principal signs of a latent metallic vein seem reducible to general heads, such as, 1. The discovery of certain mineral waters. 2. The discoloration of the trees or grass of a place. 3. The finding of pieces of ore on the surface of the ground. 4. The rise of warm exhalations. 5. The finding of metallic sands, and the like. All which are so many encouragements for making a stricter search near the places where any thing of this kind appears; whence rules of practice might be formed for reducing this art to a greater certainty. But when no evident mark of a mine appears, the skilful mineralogist usually bores into the earth, in such places as from some analogy of knowledge gained by experience, or by observing the situation, course, or nature of other mines, he judges may contain metal. After the mine is found, the next thing to be considered is whether it may be dug to advantage. In order to determine this, we are duly to weigh the nature of the place, and its situation as to wood, water, carriage, healthiness, and the like, and compare the result with the richness of the ore, and the charge of digging, stamping, washing, and smelting. Particularly, the form and situation of the spot should be well considered. A mine must either happen, 1. In a mountain. 2. In a hill. 3. In a valley. Or 4. In a flat. But mountains and hills are dug with much greater ease and convenience, chiefly because the drains and burrows, that is, the adits or avenues, may be here readily cut out, both to drain the water, and to form gangways for bringing out the ore, &c. In all the four cases, we are to look out for the veins, which the rains or other accidental thing may have laid bare; and if such a vein be found, it may often be proper to open the mine at that place, especially if the vein prove tolerably large and rich; otherwise the most commodious place for situation is to be chosen for the purpose, *viz.* neither on a flat, nor on the tops of mountains, but on the sides. The best situation for a mine, is a mountainous, woody, wholesome spot, of a fine easy ascent, and bordering on a navigable river.

**Mine**, in the Military art, denotes a subterraneous canal or passage, dug under the wall or ramparts of a fortification, intended to be blown up by gunpowder. The alley or passage of a mine is commonly about four feet square; at the end of this is the chamber of the mine, which is a cavity of about five feet in width and in length, and about six feet in height; and here the gunpowder is stowed. The saucisse of the mine is the train, for which there is always a little aperture left. Two ounces of powder have been found, by experience, capable of raising two cubic feet of earth; consequently, 200 ounces, that is, 12 pounds 8 ounces, will raise 200 cubic feet, which is only 16 feet short of a cubic toise, because 200 ounces, joined together, have proportionally a greater force than two ounces, as being an united force. All the turnings a miner uses to carry on his mines, and through which he conducts the saucisse, should be well filled with earth and dung; and the masonry in proportion to the earth to be blown up, as 3 to 2. The entrance of the chamber of the mine ought to be firmly shut with thick planks, in the form of a St. Andrew's cross, so that the enclosure be secure, and the void spaces shut up with dung or tempered earth. If a gallery be made below or on the side of the chamber, it must absolutely be filled up with the strongest masonry, half as long again as the height of the earth; for this gallery will not only burst, but likewise obstruct the effect of the mine. The powder should always be kept in sacks, which are opened when the mine is charged, and some of the powder strewed about: the greater the quantity of earth to be raised is, the greater is the effect of the mine, supposing it to have the due proportion of powder. Powder has the same effect upon masonry as upon earth, that is, it will proportionally raise either with the same velocity. The branches which are carried into the solidity of walls do not exceed three feet in depth, and two feet six inches in width nearly: this sort of mine is most excellent to blow up the strongest walls. If, when the mines are made, water be found at the bottom of the chamber, planks are laid there, on which the powder is placed either in sacks or barrels of 100 lb. each. The saucisse must have a clear passage to the powder, and be laid in an auget, or wooden trough, through all the branches. When the powder is placed in the chamber, the planks are laid to cover it, and others again across these, then one is placed over the top of the chamber, which is shaped for that purpose; between that and those which cover the powder, props are placed, which shore it up; some inclining towards the outside, others to the inside of the wall; all the void spaces being filled with earth, dung, brick, and rough stones. Afterwards planks are placed at the entrance of the chamber, with one across the top, whereon they buttress three strong props, whose other ends are likewise propped against another plank situated on the side of the earth in the branch; which props being well fixed between the planks with wedges, the branch should then be filled up to its entrance with the forementioned materials. The saucisses which pass through the side branches must be exactly the same length with that in the middle, to which they join: the part which reaches beyond the entrance of the mine is that which conveys the fire to the other three; the saucisses being of equal length, will spring together. From a great number of experiments, it appears, 1. That the force of a mine is always towards the weakest side; so that the disposition of the chamber of a mine does not at all contribute to determine this effect. 2. That the quantity of powder must be greater or less, in proportion to the greater or less weight of the bodies to be raised, and to their greater or less cohesion; so that you are to allow for each cubic fathom of loose earth, 9 or 10 lb.; firm earth and strong sand, 11 or 12 lb.; flat clayey earth, 15 or 16 lb.; new masonry, not strongly bound, 15 or 20 lb.; old masonry, well bound, 25 or 30 lb. 3. That the aperture, entonnoir, of a mine, if rightly charged, is a cone, the diameter of whose base is double the height, taken from the centre of the mine. 4. That when the mine has been overcharged, its entonnoir is nearly cylindrical, the diameter of the upper extreme not much exceeding that of the chamber. 5. That besides the shock of the powder against the bodies it takes up, it likewise crushes all the earth that borders upon it, both underneath and sideways. To charge a mine so as to have the most advantageous effect, the weight of the matter to be carried must be known; that is, the solidity of a right cone, whose base is double the height of the earth over the centre of the mine: thus, having found the solidity of the cone in cubic fathoms, multiply the number of fathoms by the number of pounds of powder necessary for raising the matter it contains; and if the cone contains matters of different weights, take a mean weight between them all, always having a regard to their degrees of cohesion. As to the disposition of mines, there is but one general rule, which is, that the side towards which one would determine the effect to be the weakest; but this varies according to occasions and circumstances. The calculation of mines is generally built upon this hypothesis, that the entonnoir of a mine is the frustum of an inverted cone, whose altitude is equal to the radius of the excavation of the mine, and the diameter of the whole lesser base is equal to the line of least resistance; and though these suppositions are not quite exact, yet the calculations of mines deduced from them, have proved successful in practice; for which reason this calculation should be followed, till a better and more simple be discovered. M. de Valliere found that the entonnoir of a mine was a paraboloid, which is a solid generated by the rotation of a semiparabola about its axis; but as the difference between these two is very insignificant in practice, that of the frustum of a cone may be used.

*Coal* **Mine.** A subterraneous excavation, from which coal is dug. The most extensive coal mines in this island are in the north of England and in Scotland. The descent to the Whitehaven mines is through spacious galleries hewn out of the rock; all the coal being cut away except large pillars, which, in deep parts of the mine, are three yards high, and about twelve yards square at the base; such great strength being there required to support the ponderous roof. These are the deepest coal mines that have been hitherto wrought; and, perhaps, no other miners have penetrated to so great a depth below the sea as those of Whitehaven; the very deep mines in Hungary, Peru, and elsewhere, being situated in mountainous regions, where the surface of the earth is elevated to a great height above the level of the ocean. There are here three strata of coal, which lie each at a considerable distance above the other, and there is a communication by pits between one of these parallel strata and another. But the vein of coal is not always regularly continued in the same inclined plane, but instead thereof, the miners meet with hard rock, which interrupts their further progress. At such places there seem to have been breaks in the earth, from the surface downwards; and in some of them it may have sunk ten or twenty fathoms, or even more. These breaks the miners call *dykes;* and when they meet with one of them, their first care is to discover whether the strata in the part adjoining be higher or lower than in the part where they have been working; or, to use their own terms, whether the coal be cast down or up. If it be cast down, they sink a pit to it; but if it be cast up to any considerable height, they are oftentimes obliged, with great labour and expense, to carry a level and long gallery through the rock, until they again arrive at the strata of coal. Those who have the direction of these deep and extensive works are obliged, with great art and care, to keep them continually ventilated with perpetual currents of fresh air. In the deserted works, which are not ventilated with perpetual currents of fresh air, large quantities of damps and noxious exhalations are frequently collected; and in such works they often remain for a long time, without doing any mischief. But when by some accident they are ignited, that is to say, set on fire, they then produce dreadful explosions, and, bursting out of the pits with great impetuosity, like the fiery eruption from burning mountains, they force along with them ponderous bodies to a great height in the air. Th coal in these mines has several times been ignited by these fulminating damps, and has continued burning for many months, until large streams of water were conducted into the mines, and suffered to fill those parts where the coal was burning. By such fires several collieries have been totally destroyed, of which there are instances near Newcastle, and in other parts of England, as well as in Fifeshire.

Professor Jameson, in his recent geological work, has scientifically described the different varieties of coal by several species and numerous sub-species; we shall here give such a description of them in regard to their practical uses, as divided into three kinds, according to their degree of inflammability. The least inflammable are Welsh Coal, Irish, and Kilkeny coal; and blind, or deaf coal, found in many parts of England, Scotland, America, and elsewhere. The last mentioned coal requires a considerable degree of heat to ignite it; but, when once kindled, its combustion lasts a long time: it remains in distinct pieces in the fire without caking, producing neither flame nor smoke, making no cinder, but leaving a stony slag; it makes a hot, glowing fire, like coals or cinders, emitting a suffocating effluvia which renders it unfit for burning in dwelling houses, &c. We think it might be used very advantageously in distilleries; as the ebullition of the liquid might be more easily regulated than with the flaming coal—a circumstance of the utmost importance to the quality of the spirit when distilled by naked fire.

Open burning coal soon kindles, making a hot, pleasant fire, but is soon consumed, and producing both flame and smoke in abundance; it lies open in the fire, and does not cake together to form cinders, its surface being burnt to ashes before it is thoroughly calcined in the middle, leaving only a white ash. Of this kind is cannel coal, jet, peacock, splint, and most of the coals in the Staffordshire coal district and in Scotland.

Close burning coal kindles quickly, makes a very hot fire, melts, and runs together like bitumen;—it makes a more durable fire than any other coal, and burns finally to ashes of a brownish colour. Of this kind are the Newcastle coal and many others. The open burning and the close burning coal, mixed together, make a more profitable fire for domestic uses than either of them separately. The various kinds of coal are often found mixed with each other under ground; and some of the finer sorts run, like veins, between those of a coarser. This natural admixture is often laid, erroneously, to the charge of the coal merchant, by persons unacquainted with the circumstance.

In the plate, fig. 1 represents a section of the Bradley mine, near Bilston in Staffordshire, exhibiting at the same time the various operations of the miners. A, the whimsey or steam engine, for raising the coal from the bottom of the shaft. B, The banksman. C, one of the shafts of the mine. D, a passage from one shaft to the other. E, the gateway, which is the first work of the miners after the shaft is sunk; it is made from eight to ten feet in height, nine feet wide, and is carried to the whole extent of the work. F, the bolt hole made to cause a free circulation of air through the mine, should any part of which take fire, the bolt hole is built up.

G, pillars left in working the ten yard coal, to support the superjacent strata. H, an excavation, called by colliers a stall, who, after the gateway is made, begin thus to work the coal, or hole under. I, the rib through which the air-way is cut. J, the lights. K, a man who hangs on the skips and rakes the gateway. L, M, N, miners, heading, holing, and shovelling out the slack or small coal. O, slack carrier. P, a miner working on a scaffold. Q, the spern, a small piece of coal left as a support to many tons above, which fall when this is taken away. R, a collier on a scaffold, taking out the spern as far as he can reach with a pick. S, a collier standing upon a heap of slack, called the gob, with a prong used for that work, which cannot with safety be done with a pick. T, a collier breaking or turning out coal. U, a collier loading a skip. V, a collier breaking the large coal with a wedge. W, a driver with an empty skip. X, a driver with a loaded skip. Y, a skip being drawn up the shaft by the engine. Z, a pillar called the *man of war*, which is left to support the upper strata until the lower are worked; it is then taken away and the upper coal falls down.

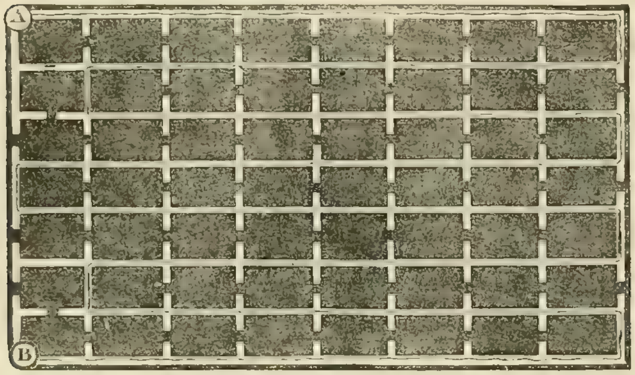
The rope or chain by which the loaded skip Y is drawn up, passes round a wheel worked by the steam-engine, and returns to the other shaft of the mine (not shewn in our engaving) where it lets down an empty skip, which is immediately released on its arrival at the bottom, and a loaded skip hooked on, to be drawn up as the one shewn descended when empty. It is an astonishing and highly amusing sight to a stranger, in the neighbourhood of Birmingham, and in other coal and iron districts, to behold at a single coup d'œil, a vast number of steam engines, with all their massive machinery and apparatus, simultaneously at work in the open air; some employed in drawing up the iron ore, others coals; which, as they emerge from the earth, are sometimes lifted upon an elevated rail road, from whence, by their own gravity or by the aid of machinery, they are at once conveyed with the rapidity of lightning, and thundering in their progress to their destination the contents instantly discharged, and the emptied skip brought back (by the advance of another that is loaded) to the mouth of the shaft, again to descend into the bowels of the earth to be re-loaded, in endless succession. The effect of this scene at night is beyond our feeble power of description, it is in every respect a moving scene; the numerous coke works just give sufficient light to see indistinctly all that is going forward, while the frequent flashing of a more intense light from other sources give a playfulness to the shadows, which picture to the mind a vast multiplication of objects.

The different strata that are cut through to arrive at the principal bed of coal, are exhibited on the left of the shaft, by variously shaded portions of the solid earth, which in Bradley mine are as follow:—

|  | FT. | IN. |
|---|---|---|
| 1. Soil on the surface, | 1 | 6 |
| 2. Clay and ratch, | 9 | 0 |
| 3. Clunch, | 2 | 6 |
| 4. Ironstone, | 0 | 2½ |
| 5. Clunch, | 2 | 0 |
| 6. Ironstone, | 0 | 2 |
| 7. Soft clay, | 0 | 2 |
| 8. Dark batty clunch, | 3 | 0 |
| 9. Gray jointy rock, | 4 | 0 |
| 10. Ironstone, | 0 | 1½ |
| 11. Rockbinds mixed with ironstone, | 4 | 0 |
| 12. Soft parting, | 0 | 1 |
| 13. Strong black rock, | 4 | 0 |
| 14. Dark clunch, | 7 | 0 |
| 15. Ironstone, | 0 | 5 |
| 16. Dark clunch, with measures of ironstone, | 5 | 0 |
| 17. Dark clunch with ditto, | 0 | 10 |
| 18. Soft clay, | 1 | 8 |
| 19. Batt, | 2 | 3 |
| 20. Brooch coal, | 3 | 6 |
| 21. Fire clay, | 0 | 4 |
| 22. Black ironstone, | 0 | 1 |
| 23. Black earth, | 1 | 6 |
| 24. Ironstone, | 0 | 2 |
| 25. Black earth and ironstone, | 1 | 6 |
| 26. Ironstone | 1 | 5 |
| 27. Rock binds with ironstone, | 10 | 0 |
| 28. Dark earth and ironstone, | 6 | 0 |
| 29. Rock binds with ironstone, | 9 | 0 |
| 30. Peldon, | 4 | 0 |
| 31. Gray rock, | 23 | 0 |
| 32. Dark clunch, | 2 | 0 |
| THE MINE. |  |  |
| 33. White coal, | 3 | 0 |
| 34. Tow coal, | 2 | 3 |
| 35. Benches and brassils, | 4 | 6 |
| 36. Foot coal, | 2 | 3 |
| 37. Slip batt, | 2 | 3 |
| 38. Slips, | 2 | 3 |
| 39. Stone coal parting, | 0 | 4 |
| 40. Stone coal and patchels, | 4 | 6 |
| 41. Penny coal, | 0 | 6 |
| 42. Springs and slipper | 4 | 6 |
| 43. Humphrey batt, | 0 | 4 |
| 44. Humphreys, | 2 | 3 |
| Depth to the bottom the shaft, | 139 | 4 |

In other mines (and probably in this at a greater depth) a single stratum will sometimes occur, of from 100 to 200 feet in thickness, with very little difference throughout the whole mass. The strata is represented in Bradley mine as nearly horizontal, but this is seldom the case, the strata lying generally in an inclined position to the horizon, which is called by the miners the dip. In consequence of this dip or descent, most of our mines have been commenced working near to the surface of the earth, and as the coal has been cleared away, the mining progressively goes on deeper and deeper. At Newcastle many of the mines extend to a considerable distance. At Whitehaven the coal works are extended more than a mile under the sea, and at between 600 and 700 feet below its bottom; and it has been observed generally, that the coals at the greatest distance under the sea are the best in quality,—hence the distinguishing term sea coal.

*Plan of the Workings of a Coal Mine, near Newcastle-upon-Tyne.*—The extensive collieries in the vicinity of Newcastle are preserved from the disastrous consequences which attend the accumulation of the fire-damp, or hydrogen gas, by a complicated and expensive system of ventilation. The following sketch represents, on a small scale, the plan which is pursued to counteract the effects of that fatal evil, and to spread throughout the workings a sufficient quantity of fresh air. The coal is worked in narrow passages called boards and headways; and the dark parts in the plan represent the pillars of coal left to support the roof. There are, generally, two descents to the mine, or more, which are distinguished by the terms of the upcast or downcast shafts. A, is the downcast shaft by which the air descends, and which is usually assisted by another shaft connected with it; the current of air is represented by the waved line, which is carried through the main passages only, the sub-ways which diverge from them being stopped up by brattices, as *a* and *b*, and its motion is accelerated by the heat of a large furnace situated at the bottom of the upcast shaft B, and thus the air, after traversing the whole of the workings, ascends the shaft B.



What is technically called the choak damp is not of so dangerous a character as the fire damp, its presence being more easily ascertained, as it immediately extinguishes the lights; it has the effect of preventing animal respiration. During gales of wind, or when the atmosphere is particularly dense, the ventilation of the mines is attended with more difficulty, and frequently in those exigencies the men are obliged to strike off work.—It is obvious that the above system of ventilation is attended with great labour and expense, not only from the number of hands employed to superintend the wastes and workings of the mine, but from the quantity of brattices which are incessantly required to stop the new ways, and where a communication must be held with the interior of the colliery. Doors at various distances are made, at each of which is placed a boy to permit the ingress and egress of the corves or baskets which contain the coal; the least negligence in closing one of these doors might be attended with serious consequences, as by changing the route of the current of air, and thus leaving unventilated a certain district of the mine, the hydrogen gas would accumulate, and upon the introduction of a candle immediately explode; from this circumstance many accidents have arisen, as no caution had been considered necessary where no danger was apprehended.

MINERAL WATERS. *See* WATERS.

MINERALOGY, is that science which treats of the solid and inanimate materials of which our globe consists; and these are usually arranged under four classes: the earthy, the saline, the inflammable, and the metallic, which are thus distinguished: 1. The earthy minerals compose the greater part of the crust of the earth, and generally form a covering to the rest. They are not remarkable for being heavy, brittle, or light-coloured. They are little disposed to crystallize, are uninflammable in a low temperature, insipid, and without much smell. 2. The saline minerals are commonly moderately heavy, soft, sapid, and possess some degree of transparency. 3. The inflammable class of minerals is light, brittle, mostly opaque, of a yellow, brown, or black colour, seldom crystallize, and never feel cold. 4. Metallic minerals are characterized by being heavy, generally opaque, tough, malleable, cold, not easily inflamed, and by exhibiting a great variety of colours, of a peculiar lustre. Under each of these classes are various genera, species, subspecies, and kinds, which it would far exceed the limits of our Dictionary to notice, and which are only properly described in very voluminous works on this particular branch of science. *See* GEOLOGY. We shall describe the external characters, which are of the first importance in facilitating our acquaintance with minerals. These are either generic or specific. The generic are certain properties of minerals, without any reference to their differences, as colour, lustre, weight, &c.; and the differences between these properties form the specific characters. Generic characters may be general or particular. In the first division are comprehended those that occur in all minerals, in the last those that are found only in particular classes of minerals. The particular generic external characters are thus advantageously arranged: 1. Colour. 2. Cohesion of particles distinguished into solid, friable, and fluid. In solid minerals are to be regarded the external shape, the external surface, and the external lustre. When broken, the lustre of the fracture, the fracture itself, and the shape of the fragments, are to be noticed. In distinct concretions, regard must be paid to the shape of the concretions, their surface, their lustre, transparency, streak, and soiling. All these may be ascertained by the eye. By the touch, we may discover the hardness of minerals, their tenacity, frangibility, flexibility, their unctuosity, coldness, weight, and their adhesion to the tongue. By the ear we distinguish their sound, and by the smell and taste the qualities which these two senses indicate. In friable minerals, external shape, lustre, aspect of particles, soiling, and degree of friability, are to be attended to. In fluid minerals, the lustre, transparency, and fluidity, are principal objects to be regarded. The specific external characters of minerals are founded on the distinctions and varieties of the two great generic divisions. And first, of colours, the names of which are derived from certain bodies in which they most generally occur, either in a natural or artificial state, or from different mixtures and compositions of both.

I. *Colour.*—1. White. This may be snow-white, reddish-white, yellowish-white, silver-white, grayish-white, greenish-white, milk-white, or tin-white. 2. Gray. Lead-gray, bluish-gray, pearl-gray, reddish-gray, smoke-gray, greenish-gray, yellowish-gray, steel-gray, and ash-gray. 3. Black. Grayish-black, brownish-black, dark-black, iron-black, greenish-black, and bluish-black. 4. Blue. Indigo-blue, Prussian-blue, lavender-blue, smalt-blue, sky-blue. 5. Green. Verdigris-green, celaden-green, mountain-green, emerald-green, leek-green, apple-green, grass-green, pistachio-green, asparagus-green, olive-green, blackish-green, canary-green. 6. Yellow. Sulphur-yellow, lemon-yellow, gold-yellow, bell-metal-yellow, straw-yellow, wine-yellow, Isabella-yellow, ochre-yellow, orange-yellow, honey-yellow, wax-yellow, brass-yellow. 7. Red. Morning-red, hyacinth-red, brick-red, scarlet-red, copper-red, blood-red, carmine-red, cochineal-red, crimson-red, columbine-red, flesh-red, rose-red, peach-blossom-red, cherry-red, brownish-red. 8. Brown. Reddish-brown, clove-brown, hair-brown, yellowish-brown, tombac-brown, wood-brown, liver-brown, blackish-brown. Besides these distinctions, colours may be clear, dark, light, or pale; they may have a tarnished appearance, a play, a changeability, an iridescent, an opalescence, a permanent alteration, and a delineation of figure or pattern, such as dotted, spotted, clouded, flamed, striped, veined, dendritic, or uniform.

II. *Cohesion of Particles.*—Minerals are divided into, 1. Solid, or such as have their parts coherent, and not easily moveable; 2. Friable, or that state of aggregation in which the particles may be overcome by simple pressure of the finger; and, 3. Fluid, or such as consist of particles which alter their place in regard to each other by their own weight.

1. Solid Minerals.—External aspect has three things to be regarded, 1. The shape; 2. The surface; and, 3. The lustre. The external shape again may be common, particular, regular, or extraneous; and hence arises the specific differences. 1.

The common external shape may be massive, disseminated coarsely, minutely, or finely; in angular pieces, sharp-cornered or blunt-cornered; in grains, large, coarse, small, fine, angular, flat, round; in plates, thick or thin; in membranes or flakes, thick, thin, or very thin. The particular external shape may be longish, as dentiform, filiform, capillary, reticulate, dendritic, coralliform, stalactitic, cylindrical, tubiform, claviform, or fruticose; roundish, as globular, spherical, ovoidal, spheroidal, amygdaloidal, botryodal, reniform, tuberose, or fused-like; flat, as specular, or in leaves; cavernous, as cellular in various forms, with impressions, perforated, corroded, amorphous, or vesicular; entangled, as ramose, &c. In the regular external shape or crystallization are to be regarded its genuineness, according to which it may be either true or supposititious; its shape, made up of planes, edges, angles, in which are to be observed the fundamental figure and its parts, the kind of fundamental figure, the varieties of each kind of fundamental figure with their accidents and distinctions, and the alterations which the fundamental figure undergoes by truncation, by bevelment, by acumination, or by a division of the planes. There are a variety of figures under each of these sub-divisions. It must be remarked also that the external shape may be extraneous, or derived from the animal and vegetable kingdoms, as in fossils and petrifications. 2. The external surface contains several varieties of distinctions. It may be uneven, granulated, rough, smooth, or streaked in various ways and directions. 3. The external lustre is the third generic external character, and is of much importance to be attended to. In this we have to consider the intensity of the lustre, whether it is splendent, shining, glistening, glimmering, or dull; next the sort of lustre, whether metallic or common. The latter is distinguished into semi-metallic, adamantine, pearly, resinous, and vitreous.

Aspect of the Fracture of Solid Minerals.—After the external aspect, the fracture forms no inconsiderable character in minerals. Its lustre may be determined as in the external lustre; but the fracture itself admits of great varieties. It may be compact, splintery, coarsely splintery, finely splintery, even, conchoidal, uneven, earthly, hackly. If the fracture is fibrous, we are to consider the thickness of the fibres, if coarse or delicate, the direction of the fibres, if straight or curved; and the position of the fibres, if parallel or diverging. In the radiated fracture we are to regard the breadth of the rays, their direction, their position, their passage or cleavage. In the foliated fracture, the size of the folia, their degree of perfection, their direction, position, aspect of their surface, passage or cleavage, and the number of cleavages, are to be noted. The shape of the fragments may also be very various, regular, as cubic, rhomboidal, trapezoidal, &c., or irregular, as cuneiform, splintery, tabular, indeterminately angular.

Aspect of the distinct Concretions.—The aspect of the distinct concretions forms very prominent external characters. They may be granular, different in shape, or in magnitude; they may be lamellar, distinct, concretious, differing in the direction of the lamellæ, in the thickness, with regard to shape, and in the position. The surface of the distinct concretions may be smooth, rough, streaked, or uneven; as for their lustre, it may be determined in the same manner as the external lustre.

General Aspect as to Transparency.—Minerals, as is well known, have different degrees of transparency, which may be considered among their external characters. They may be transparent, semitransparent, translucent, translucent at the edges, or opaque.

The Streak.—The colour of this external character may be either similar or different. It is presented to us when a mineral is scraped with the point of a knife; and is similar, when the powder that is formed is of the same colour with the mineral, as in chalk; or dissimilar or different, as in cinnabar, orpiment, &c.

The Soiling or Colouring.—Is ascertained by taking any mineral substance between the fingers, or drawing it across some other body. It may soil strongly, as in chalk; slightly, as in molybdena; or not at all, which is a quality belonging to most of the solid minerals. All the preceding external characters are recognized by the eye.

External Characters from the Touch.—These are eight in number, and are not destitute of utility to the mineralogical student. 1. Hardness; 2. Tenacity; 3. Frangibility; 4. Flexibility; 5. Adhesion to the tongue; 6. Unctuosity; 7. Coldness; 8. Weight. Hardness may be tried by a capacity to resist the file, yielding a little to it, by being semi-hard, soft, or very soft. Tenacity has different degrees, in substances being brittle, sectile or mild, or ductile. The frangibility consists in minerals being very difficultly frangible, easily frangible, or very easily frangible. The flexibility is proved by being simply flexible, elasticly flexible, commonly flexible, or inflexible. The adhesion to the tongue may be strongly adhesive, pretty strongly, weakly, very weakly, or not at all. Unctuosity may be meagre, rather greasy, greasy, or very greasy. Coldness is subdivided into cold, pretty cold, rather cold. Weight may be distinguished into swimming or supernatant, light, rather light, heavy, very heavy. The three last divisions from the touch, are in the Wernerian system regarded as anomalous; but they seem properly to be classed under this head.

External Characters from the Sound or Hearing.—The different kinds of sound which occur in the mineral kingdom are, 1. A ringing sound, as in native arsenic and thin splinters of hornstone; 2. A grating sound, as in fresh-burnt clay; 3. A creeking sound, as that of natural amalgam.

2. Friable Minerals.—The external characters drawn from minerals of this class, are derived, first, from the external shape, which may be massive, disseminated, thinly coating, spumous, or dentritic: secondly, from the lustre, regarded under its intensity, whether glimmering or dull, and its sort, whether common glimmering or metallic glimmering; thirdly, from the aspect of the particles, as being dusty or scaly: fourthly, from soiling or colouring, as strongly or lightly; and lastly, from the friability, which may be loose or cohering.

3. Fluid Minerals.—Of external characters drawn from fluid minerals, there are only two kinds, which include three varieties: 1. The lustre, which is either metallic, as in mercury; or resinous, as in rock oil. 2. The transparency, which is transparent, as in naphtha; turbid, as in mineral oil; or opaque, as in mercury. 3. The fluidity, which may be fluid, as in mercury; or viscid, as in mountain tar.

External Characters from the Smell.—These may be spontaneously emitted and described as bituminous, faintly sulphurous, or faintly bitter; or they may be produced by breathing on, and yield a clay-like smell; or they may be excited by friction, and smell urinous, sulphureous, garlic-like, or empyreumatic.

External Character from the Taste.—This character prevails chiefly in the saline class, and it contains the following varieties: a sweetish taste, sweetish astringent, styptic, salty bitter, salty cooling, alkaline, or urinous.

Having now given a synoptical view of the external characters of minerals, we shall proceed to their classification, and in this we shall chiefly follow the names and arrangement of Professor Jameson.

Class I. *Earthy Fossils.*—Genus I. Diamond. This precious stone has great variety of shades, exhibiting a beautiful play of colours. It occurs in angular and spherical grains, which present planes of crystallization, or are actually crystallized. Its fundamental crystal is the octahedron, which passes into various forms. It is hard, brittle, frangible, and has a specific gravity of 3 600. The diamond has, by modern experiments, been proved to be nearly pure carbon, and begins to burn at 14 deg. or 15 deg. of Wedgewood.

Genus II. Zircon.—Species 1, Zircon; which see. 2, Hyacinth. A rectangular four-sided prism, flatly acuminated by four planes, set in the lateral edges. Of this figure, however, several varieties occur. Crystals generally small, and always imbedded: the lateral planes smooth, externally shining: internally splendent and glassy, inclining somewhat to resinous.

Genus III. Flint.—Species 1, Chrysoberul. General colour asparagus-green, passing into a variety of allied shades. It exhibits a milk-white light; occurs in roundish and angular grains, which sometimes approach in shape to the cube. It is seldom crystallized; but when in this state, it presents a long six-sided table, having truncated lateral edges, and longitudinally streaked lateral planes. The crystals are small, externally shining, and internally splendent. It is hard, brittle; not easily frangible, with a specific gravity of 3·600: without addition, infusible. 2, Chrysolite. The colour is pistachio-green, of all degrees of intensity: external surface of the crystals splendent, internally splendent, and vitreous. 3, Olivine. Generally asparagus-green, of various degrees of intensity. It is found imbedded also in round pieces and grains; when crystallized, which is rare, in rectangular four-sided prisms. Internally shining, varying between glistening and splendent; semitransparent, easily frangible; in a low degree hard, and not particularly heavy. It is nearly fusible without addition. Occurs imbedded in basalt. 4, Augite. Colour blackish-green. It occurs chiefly in indeterminate angular pieces and roundish grains. Occasionally crystallized, and presents broad rectangular six-sided prisms. The crystals are mostly small. Internally the lustre is shining, approaching sometimes to splendent. The augite is only translucent, and but faintly transparent. It is hard, not easily frangible, and not particularly heavy. It is found in basalt, either singly, or accompanied with olivine. 5, Vesuviane. Its principal colour is dark olive-green, passing into other allied shades. It occurs massive, and often crystallized in rectangular four-sided prisms. The crystals are mostly short, and placed on one another. The vesuviane is translucent, hard in a moderate degree, and approaching to heavy. Before the blowpipe it melts without addition. It is found among the exuviæ of Vesuvius, whence it derives its name; in Siberia and Kamtschatka. 6, Leuzite. In colour yellowish and grayish-white. It occurs mostly in original round and angular grains. It exhibits acute double eight-sided pyramids. Internally it is shining, and approaching to glistening, with a vitreous lustre, inclining somewhat to resinous. The leuzite is translucent and semitransparent; hard in a low degree, brittle, easily frangible, and not very heavy. With borax, it forms a brownish transparent glass. It is found in rocks of the newest floetz trap formation, particularly in basalt. 7, Melanite. In colour velvet-black. It occurs crystallized in a six-sided prism. The crystals are middle-sized or small. Externally they are smooth and shining, approaching to splendent; internally shining, inclining to glistening. The melanite is opaque, hard, pretty easily frangible, and not very heavy. It occurs imbedded in rocks of the newest floetz trap formation. 8, Garnet; *see* GARNET. 9, Pyrope. Colour dark blood-red. It occurs in small and middle-sized, roundish, and angular grains; but never crystallized. Its lustre is splendent and vitreous. It is completely transparent, hard so as to scratch quartz. It is found imbedded in Scotland, in sand, on the sea shore. It is employed in various kinds of jewellery, and is generally set in a gold foil. 10, Grenatite. Colour a dark reddish-brown. It is always crystallized in broad six-sided prisms. The crystals small and middle-sized, internally glistening, with a lustre between vitreous and resinous. It varies from opaque to translucent, is hard, brittle, easily frangible, and not particularly heavy. It is found imbedded in mica slate. 11, Spinelle. The predominant colour is red, which passes on into blue, green, yellow, and brown. It occurs in grains, and likewise crystallized in octahedrons, with several variations. Externally and internally the lustre is splendent and vitreous. It is fusible with borax: occurs in rocks belonging to the newest floetz trap formation. It is used as a precious stone. 12, Sapphire. The principal colour Berlin blue: but it is found also red, with the intermediate shades of these two colours. It occurs in small rolled pieces, and crystallized in double three-sided pyramids. The crystals are small and middle-sized. Internally the lustre is splendent and vitreous. Some varieties, when cut, exhibit a star of six rays. The sapphire is hard in the highest degree, but yields to the diamond: it is easily frangible; specific gravity of about 4·000. It is fusible without addition: occurs in rocks of the newest floetz trap formation. This precious stone is found in the utmost beauty in Pegu and Ceylon. 13, Corundum; *see* CORUNDUM. 14, Diamond Spar. The colour is a dark hair-brown. It occurs massive, disseminated, in rolled pieces, and crystallized in six-sided prisms, or very acute six-sided pyramids. Internally, its lustre is splendent: translucent on the edges, hard in a high degree, easily frangible. It has hitherto been found only in China. Both this stone and corundum are employed in cutting and polishing hard minerals, and they seem to be nearly allied to each other. 15, Emery; *see* EMERY. 16, Topaz. The chief colour is a wine-yellow, of all degrees of intensity. It is found massive, disseminated, and sometimes rolled, but most commonly crystallized in oblique eight-sided or four-sided prisms, which exhibit several varieties. The crystals are small and middle-sized, externally splendent; internally splendent and shining; lustre vitreous. The topaz alternates from translucent to transparent, and is duplicating transparent. It is hard in a high degree, easily frangible, and is not particularly heavy. It is fusible with borax; and some kinds in a gentle heat turn white, and are sometimes sold for diamonds. It is commonly found in veins that traverse primitive rocks. 17, Emerald; which see. 18, Beryl; *see* BERYL. 19, Schorl. Divided into two sub-species, common schorl and tourmaline. 20, Thumerstone. Colour commonly clove-brown, of various degrees of intensity. It is occasionally found massive, more frequently disseminated: but generally crystallized in very flat and oblique rhombs. Externally, its lustre is splendent: internally, it alternates from glistening to shining, and is vitreous. This species alternates from perfectly transparent to weakly translucent. It appears to be peculiar to the primitive mountains. 21, Iron Flint. The colour a yellowish-brown, bordering on liver-brown. It occurs commonly massive, but also crystallized in small equiangular six-sided prisms. Externally, its lustre is splendent, internally shining, and is intermediate between vitreous and resinous. It is opaque, and slightly translucent on the edges. It is pretty hard, somewhat difficultly frangible, and approaching to heavy. It occurs in iron-stone veins, and renders the ore very difficult of fusion. 22, Quartz. Werner divides this into five sub-species: amethyst, rock-crystal, milk-quartz, common quartz, and prase. 23, Hornstone; which see. 24, Flint. Colour gray, but with many varieties. It occurs massive, in regular plates, in angular grains, in globular and elliptical rolled pieces, in the form of sand, and tubercles and perforated. Sometimes it is crystallized, in double six-sided prisms, or flat double three-sided pyramids. Internally, the lustre is glimmering, translucent on the edges, hard, easily frangible, and not particularly heavy. 25, Chalcedony. Divided into two sub-species, chalcedony and cornelian; which see. Agate. The fossils known under this name are all compound substances; and hence cannot have a particular place in any systematic arrangement. Werner, therefore, has placed them as a supplement to the species chalcedony, which forms a principal constituent part of them. *See* AGATE. 26, Heliotrope; which see. 27, Plasma. The colour intermediate between grass and leek-green, and of different degrees of intensity. It occurs in indeterminable angular pieces which have a rough earthy crust. Internally its lustre is glistening. It is intermediate between semi-transparent and strongly translucent, hard, brittle, frangible without great difficulty, and not particularly heavy. 28, Chrysopras. 29, Flinty Slate. This has been divided into two sub-species, common flinty slate and Lydian stone. 30, Cat's Eye. The colour gray, with many varieties. It occurs in blunt-edged pieces, in rolled pieces, and likewise massive. Internally shining; usually translucent, and sometimes also semi-transparent. It is hard, easily frangible, and not particularly heavy. Its geognostic situation is unknown. It is imported from Ceylon and the coast of Malabar; and is usually cut for ring-stones. Some of the varieties are highly valued. 31, Prehnite. Colours various shades of green, white, and yellow. It is sometimes massive, and sometimes crystallized in oblique four-sided tables. Externally, the crystals are smooth and shining; internally, inclining to glistening and pearly. It is translucent, sometimes passing into semi-transparent, and transparent: it is hard, easily frangible, and not very heavy. 32, Zeolite. This species is divided into five sub-species: 1. Mealy; 2. Fibrous; 3. Radiated; 4. Foliated; 5. Cubic-zeolite. 33, Cross-Stone. The colour is a grayish-white. It occurs crystallized either in broad rectangular four-sided prisms, or in twin crystals. Internal and external lustre is shining, inclining to splendent or glistening. The cross-stone is translucent, passing to transparent, semi-hard, easily frangible, and not particularly heavy. It has hitherto been found only in mineral veins, and in agate balls. 34, Agate-Stone. Colour a perfect azure blue, of different shades. It is found massive, disseminated, and in rolled pieces. The lustre is glistering and glimmering. It is translucent on the edges, pretty hard, brittle, easily frangible, and not particularly heavy. *See* AGATE.

Genus IV. Clay.—Species 1, Jasper. 2, Opal. 3. Pitch Stone. 4, Obsidian. 5, Pearl Stone. 6, Pumice Stone. 7, Felspar. Divided into four sub-species; compact, common, adularia, and Labrador stone. 8, Pure Clay. Snow white, with occasionally a yellowish tinge, it occurs in kidney-shaped pieces, which have no lustre. It is opaque, soils very little, adheres slightly to the tongue, is light, and intermediate between soft and friable. Pure clay is found immediately under the soil, accompanied with foliated gypsum and selenite, at Halle, in Saxony, only. 9, Porcelain Earth. 10, Common Clay. Divided into six sub-species: 1. Loam; 2. Potters' clay is of two kinds, earthy and slaty; 3. Pipe clay; 4. Variegated clay, commonly white, red, and yellow, striped, veined, and spotted: it occurs massive, is soft, passing into friable, feels a little greasy, and adheres somewhat to the tongue: 5. Clay-stone, commonly gray or red, with various intermediate tints; 6. Slate clay. 11, Polier, or Polishing-stone. 12, Tripoli. 13, Alum Stone. 14, Alum Earth. 15, Alum Slate. 16, Bituminous Shale. 17, Drawing Slate, or Black Chalk. Its colour is a grayish-black, with a tinge of blue; it occurs massive, is opaque, colours and writes, is soft, mild, easily frangible, feels meagre but fine, and is rather light: it is found in primitive mountains in France, Germany, Iceland, Scotland, and the Hebrides. When of a middling degree of hardness, it is used for drawing. 18, Whet Slate. 19, Clay Slate. 20, Lepidolite. Colour a kind of peach-blossom, it occurs massive. Internal lustre glistening; it is translucent, soft, easily frangible, and easily melts before the blowpipe. Hitherto it has only been found in Moravia, where it lies in gneiss. 21, Mica, or Glimmer. 22, Pot Stone. 23, Chlorite, which see. 24, Hornblende. 25, Basalt. 26, Wacke. 27, Clink Stone. Commonly of a dark greenish-gray colour, massive, in regular columns, and tabular distinct concretions, usually translucent on the edges, brittle, easily frangible, and when struck with a hammer sounding like a piece of metal. It is said to belong to the floetz trap formation, and generally rests on basalt. 28, Lava. Divided into two sub-species; Stag-lava and Toam-lava. 29, Green Earth. Its colour is a celaden-green, of various degrees of intensity: it occurs massive, in angular and globular pieces, and also disseminated. Internally it is dull, streak glistening, very soft, easily frangible, and light. It is principally found in amygdaloid, in Saxony, Bohemia, Scotland, and other places, and is used by painters. 30, Lithomage. Divided into two sub-species; friable and indurated. 31, Rock Soap. 32, Yellow Earth. To the clay genus, likewise, belong adhesive slate, float-stone, pinite, and umber.

Genus V. Talc.—Species 1, Bole. 2, Native Talc Earth. 3, Meerschaum. 4, Fullers' Earth. 5, Neaphrite. 6, Steatite. 7, Serpentine, which see. 8, Schiller Stone. 9, Talc. 10, Asbest. *See* ASBESTOS. 11, Cyanite, which see. 12, Actynolite. Is divided into the following sub-species: 1. Asbestous actynolite is of a greenish-gray colour, occurs massive, disseminated, and in capillary crystals; is internally glistening, translucent on the edges, soft, brittle, not easily frangible, not particularly heavy: it is found in mineral beds in Saxony, and other parts of Germany. 2. Common actynolite is generally of a green leek colour, passing into other shades of the same; it occurs massive, and likewise crystallized in very oblique six-sided prisms, is splendent externally, semi-hard, rather brittle, and not easily frangible: it is found in beds in primitive mountains, in Saxony, Switzerland, Norway, and Scotland. 3. Glassy actynolite is principally of a mountain green colour, of various degrees of intensity.

Genus VI. Calc.—Species 1, Rock Milk. 2, Chalk. Colour principally of a yellowish-white: it occurs massive, disseminated, and as crust over flint. 3, Lime-stone. Divided into several sub-species: *viz.* compact, foliated lime-stone, fibrous lime-stone, and pea stone. 4, Schaum, or Foaming Earth. 5, Slate spar. 6, Brown spar. 7, Rhomb spar. 8, Schaalstone. 9, Stink-stone. 10, Marle. 11, Bituminous marle slate. Colour intermediate between grayish and brownish-black; it is massive, from glimmering to shining, fragments slaty, usually soft, not very brittle, easily frangible, and streak shining: it is found in beds along with the oldest floetz lime-stone, and contains much copper intermixed with it, on account of which it is usually smelted in Thuringia. 12, Calc tuff. 13, Arragonite Principal colours are greenish-gray and iron-gray: it occurs crystallized in perfect equiangular six-sided prisms; the lustre is glistening, passing into shining, and is vitreous; it is semi-hard, brittle, not particularly heavy. It was first discovered in the province of Arragon, whence its name, imbedded in gyps. 14, Appatite. Colours white, green, blue, and red; it generally occurs crystallized, the radical form of which is the equiangular six-sided prism. Externally it is splendent, internally shining and resinous: it is commonly transparent, semi-hard, brittle, easily frangible, and occurs in thin veins, &c. 15, Asparagus, or spargel stone. 16, Boracite. Its colours are yellowish, smoke and grayish-white, passing to asparagus green; it occurs in crystallized cubes, with the edges and angles truncated, internally shining, commonly semi-transparent, semi-hard, brittle, and easily frangible. 17, Fluor. *See* FLUOR. 18, Gyps. This is divided into the following sub-species: 1. Gyps earth, of a yellowish-white colour, passing into some allied shades, is intermediate between fine scaly, and dusky, dull, and feebly glimmering, soils a little, feels meagre but soft and fine, and is light; it is found, though rarely, in gyps countries. 2. Compact gyps, is commonly ash-gray, passing into smoke and yellowish-gray, is massive, internally dull, feebly translucent on the edges, very soft, frangible without great difficulty, and is employed in architecture and sculpture, under the name of alabaster. 3. Foliated gyps is commonly white, gray, or red, presenting spotted, striped, and veined colour delineations. 4. Fibrous gyps is principally white, gray, and red, with various shades of each. Gyps, when burnt, forms an excellent cement, and is used for many ornamental purposes. 19, Selenite. 20, Cube spar.

Genus VII. Baryte.—Species 1, Whitherite. 2, Heavy spar or baryte.

Genus VIII. Strontian.—Species 1, Strontian. 2, Celestine. Divided into two sub-species: 1. Fibrous celestine, is of an intermediate colour, between indigo blue and bluish-gray; it occurs massive and in plates, and also crystallized, shewing a tendency to prismatic distinct concretions; it is translucent, soft, or semi-hard, easily frangible, and pretty heavy. 2. Foliated celestine, is of a milky-white colour falling into blue; it occurs massive, and also crystallized in six-sided tables, intersecting each other; it has a glistening lustre, is strongly translucent, softish, not particularly brittle, easily frangible, and hard. It occurs sometimes in sulphur beds, and is found very finely crystallized in Sicily, and near Bristol.

Class II. *Fossil Salts.*—The substances included in this class are confined to those which are found in a natural state only; and the greater part of them appear to be formed by the agency of water, air, &c. The distinguishing characters of fossil salts are, their taste and easy solution. They resemble each other so closely, that the term *saline consistence* is used to express whatever relates to hardness, tenacity, and frangibility.

Species 1, Natron, or natural soda. 2, Natural nitre. 3, Natural rock-salt. 4, Natural sal-ammoniac. 5, Natural Epsom salt. 6, Natural Glauber salt. 7, Natural alum. 8, Hair salt. 9, Rock butter. Colour light yellow, or grayish-white; it occurs massive and tuberose, is translucent, has a saline consistence, a sweetish sour astringent taste, and feels a little greasy. It oozes out of fissures of rocks of alum slate, and is found in Lusatia, Thuringia, Denmark, Siberia, and near Paisley in Scotland. 10, Natural vitriol. Divided into the sub-species: iron, copper, and zinc vitriol. Borax, though so well known by name, is without a place in the Wernerian system, as it is uncertain whether or not it occurs in a solid state; most probably it occurs only in solution in certain lakes. The new genus stallite, of which only one species, cryolite, has been found in Greenland, comes under this head.

Class III. *Inflammable Fossils.*—Fossils belonging to this class are light, brittle, mostly opaque, yellow, brown, or black, seldom crystallized, and never feel cold. They are more nearly allied to the metallic than to the earthy or saline classes.

Genus I. Sulphur.—Species 1, Natural sulphur.

Genus II. Bituminous.—*See* BITUMEN and COAL.

Genus III. Graphite.—Species 1, Glance coal. Divided into two sub-species: conchoidal and slaty. 2, Graphite, containing two sub-species, scaly and compact graphite. 3, Mineral charcoal. Colour a grayish-black: it occurs in small angular and somewhat cubical-shaped pieces, is glimmering, with a silky lustre, soils strongly, is soft, and light. It is found in thin layers in different kinds of coal, and is widely disseminated.

Genus IV. Resin.—Species 1, Amber; which is divided into the sub-species: 1. White; 2. Yellow amber. 2, Honey-stone. Mellite.

CLASS IV. *Metallic Fossils.*—Genus I. Platina. Species 1, Native platina.

Genus II. Gold.—Species 1, Native gold. Divided into three sub-species: 1. Gold-yellow native gold; 2. Brass-yellow native yellow; 3. Grayish-yellow native gold.

Genus III. Mercury.—Species 1, Native mercury, or quicksilver. 2, Natural amalgam. 3, Mercurial horn-ore, or corneous mercury. 4, Mercurial liver ore, or mercurial hepatic ore. 5, Cinnabar.

Genus IV. Silver.—Species 1, Native silvèr. 2, Antimonial silver. 3, Arsenical silver. 4, Corneous silver ore, or horn ore. 5, Silver black. 6, Silver glance. 7, Brittle silver glance. 8, Red silver ore. 9, White silver ore. 10, Black silver ore.

Genus V. Copper.—Species 1, Native copper. 2, Copper glance. 3, Variegated copper ore. Colour, when dug, intermediate between copper-red and pinchbeck-brown, but it soon becomes tarnished: it occurs massive, disseminated in plates, membranes, and crystallized in octahedrons. 4, Copper pyrites. 5, White copper ore. 6, Gray copper ore, or Fahl ore. Common colour steel-gray: it occurs massive, disseminated, and also crystallized in tetrahedrons, octahedrons, and garnet dodecahedrons. 7, Copper black. 8, Red copper ore. 9, Tile ore. 10, Copper azure. 11, Melachite. 12, Copper green. Colour verdigris green, of different degrees of intensity. 13, Iron-shot copper ,green. 14, Copper emerald. 15, Copper mica. Emerald-green colour: it occurs massive, disseminated, and occasionally crystallized in very thin six-sided tables; it is soft, sectile, not very brittle, nor particularly heavy; and has hitherto been found only in veins in Cornwall, where it passes under the unscientific name of foliatic arseniate of copper. 16, Lenticular ore. 17, Olive ore. Mountain blue.

Genus VI. Iron.—Species 1, Native iron. Is of a light steel-gray colour, inclining to silver-white: it has hitherto been found only ramose; internally it is intermediate between glimmering and glistening, with a perfect metallic lustre, and a hackly fracture: it is between soft and semi-hard, perfectly malleable, common, flexible, difficultly frangible, and uncommonly heavy. Hitherto it has been found only in loose masses on the surface of the earth, and is a rare production. 2, Iron pyrites. 3, Magnetic pyrites. 4, Magnetic iron-stone. Common magnetic iron-stone is of an iron black-colour: is massive, disseminated, and also crystallized in cubes, octahedrons, and garnet dodecahedrons, and rectangular four-sided prisms. It is extremely shining; internally between splendent and glistening, with a metallic lustre; is intermediate between hard and semi-hard, brittle and heavy. It occurs most frequently in primitive mountains. When pure it affords most excellent bar iron. 5, Iron glance. Common iron glance is usually of a dark steel-gray colour, with several different shades; it commonly occurs massive and disseminated, and also crystallized in flat, double, three-sided pyramids, and in double three-sided pyramids. It offers, when smelted, an excellent malleable iron. 6, Red iron-stone. Red iron froth. The colour is intermediate between cherry-red and brownish-red; it occurs commonly friable, massive, sometimes coating and disseminated, and is composed of scaly particles, which are glimmering, and have a semi-metallic lustre. 7, Brown iron-stone. Brown iron froth is of an intermediate colour between steel-gray and clove-brown, and is between friable and solid; it occurs massive, coating, spumous, &c., and is composed of scaly particles, shining and glistening, with a metallic lustre. It soils strongly, feels greasy, and is very light. It is commonly found lining dusty cavities. 8, Sparry iron-stone. The principal colour is a light yellowish-gray, which, on exposure to the air or heat, changes into brown or black; it occurs massive, disseminated with pyramidal impressions, in plates, and crystallized. It is chiefly confined to the primitive and floetz mountains. 9, Black iron-stone. 10, Clay iron-stone. Reddle is of a light brownish-red, passing into a cherry-red: it occurs only massive; soils strongly, and writes, is sectile, easily frangible, and rather heavy. It is chiefly found in the newer clay-state, in Germany and Siberia. The coarser varieties are used by the carpenter, the finer by the painter, under the name of red chalk. 11, Bog iron ore. 12, Blue iron-earth. 13, Green iron-earth. Friable green iron-earth is of a siskin-green colour; occurs massive and disseminated, is more or less cohering, soft, fine, easily frangible, and intermediate between particularly heavy and heavy. 14, Cube ore.

Genus VII. Lead.—Species 1, Lead glance. Common lead glance is of a fresh lead-gray colour, of different degrees of intensity; it occurs massive, disseminated, in membranes, &c., and also crystallized in cubes, octahedrons, four-sided prisms, six-sided prisms, and three-sided tables. It is soft, sectile, externally easily frangible, and uncommonly heavy, and is found in veins and beds in primitive, transitive, and floetz mountains. It is most frequently worked as an ore of lead, but sometimes as an ore of silver. 2, Blue lead ore. 3, Brown lead ore. 4, Black lead ore. 5, White lead ore. 6, Green lead ore. 7, Red lead ore. 8, Yellow lead ore. 9, Lead vitriol, or vitriol of lead. 10, Lead earth.

Genus VIII. Tin.—Species 1, Tin pyrites. 2, Tin stone. 3, Cornish tin ore, or wood tin.

Genus IX. Bismuth.—Species 1, Native bismuth. 2, Bismuth glance, of a light-gray lead-colour. 3, Bismuth-ochre, of a straw-yellow colour passing into other neighbouring shades.

Genus X. Zinc.—Species 1, Blende. 2, Calamine.

Genus XI. Antimony.—Species 1, Native antimony. 2, Gray. 3, Black. 4, Red. 5, White antimony ore. 6, Antimony-ochre.

Genus XII. Cobalt.—Species 1, White cobalt ore. 2, Gray cobalt ore. 3, Cobalt glance. The colour is of a silver-white, slightly inclining to reddish: it is commonly massive and disseminated, sometimes crystallized in different forms: is externally splendent, internally between shining and glistening, and has a metallic lustre. It is semi-hard, brittle, not very easily frangible; and when struck with steel, emits an arsenical smell. It is found in veins in various formations, in the different mine countries of the continent of Europe; and from it the greatest part of the cobalt in commerce is obtained, which is highly useful in the manufacture of glass, and as a pigment. 4, Black cobalt ore. 5, Brown cobalt ochre. 6, Yellow cobalt ochre. 7, Red cobalt ochre.

Genus XIII. Nickel.—Species 1, Copper nickel. 2, Nickel ochre.

Genus XIV. Manganese.—The three species are, 1. Gray; 2. Black; 3. Red manganese ore.

Genus XV. Molybdena.—Species 1, Molybdena.

Genus XVI. Arsenic.—Species 1, Native arsenic. 2, Arsenic pyrites. 3, Orpiment. 4, Arsenic bloom.

Genus XVII. Scheele.—Species 1, Tungsten. 2, Wolfram.

Genus XVIII. Menachine.—Species 1, Menachanite. 2, Octahedrite. 3, Rutile. 4, Nigrine. 5, Iserine.

Genus XIX. Uran.—Species 1, Pitch ore. 2, Uran mica 3, Uran ochre.

Genus XX. Sylvan.—Species 1, Native sylvan. 2, Graphic ore. 3, Yellow sylvan ore. 4, Black sylvan ore.

Genus XXI. Chroma.—Species 1, Acicular, or needle ore. Its colour is dark steel-gray: occurs in imbedded acicular crystals; internally shines with a metallic lustre, is soft, not very brittle, heavy, and is always accompanied with chrome ochre, and sometimes with native gold. It is found in Siberia. 2, Chrome ochre. It is of a verdigris green, passing through several neighbouring shades: it occurs massive, disseminated, and in membranes; is dull, soft, not very heavy, and is found with the preceding species.

For the various forms which minerals are found under, see CRYSTALLIZATION.

**MINIATURE**, a delicate kind of painting distinguished by the smallness of the figures, its being performed with dots or points instead of lines; by the faintness of the colouring; and by its being usually done on vellum. *See* PAINTING.

**MINISTER**, in Theology, a person who preaches, performs religious worship in public, administers the sacrament, &c.

Minister *of State*, a person to whom a sovereign prince intrusts the administration of the government.

Minister, *Foreign*, is a person sent into a foreign country to manage the affairs of his province, or of the state to which he belongs. Of these there are two kinds: those of the first rank are ambassadors and envoys extraordinary, who represent the persons of their sovereigns. The ministers of the second rank are the ordinary residents.

**MINIUM**, in the Arts, red lead and oxide of lead.

**MINOR**, in Law, is an heir, either male or female, before arriving at the age of twenty-one; during their minority, minors are usually incapable of acting for themselves, in a legal point of view.

Minor, in Logic, the second proposition of a syllogism.

**MINSTREL**, in ancient customs, certain persons who combined the character of poet and musician, and whose profession it was to wander about the countries they inhabited, singing panegyrical songs and verses on their occasional benefactors, accompanying them with some musical instrument.

**MINT**, the place in which the king's money is coined. *See* Coinage. There were anciently mints in almost every county in England; but the only mint at present in the British dominions, is that in the Tower of London. The officers of the mint are, 1. The warden of the mint, who is the chief; he oversees the other officers, and receives the bullion. 2. The master worker, who receives bullion from the warden, causes it to be melted, delivers it to the moneyers; and when it is coined, receives it again. 3. The comptroller, who is the overseer of all the inferior officers, and sees that all the money is made to the just assize. 4. The assay master, who weighs the gold and silver, and sees that it is according to the standard. 5. The two auditors, who take the accounts. 6. The surveyor of the melting, who, after the assay master has made trial of the bullion, sees that it is cast out, and not altered after it is delivered to the melter. 7. The engraver, who engraves the stamps and dies for the coinage of the money. 8. The clerk of the irons, who sees that the irons are clean and fit to work with. 9. The melter, who melts the bullion before it be coined. 10. The provost of the mint, who provides for and oversees all the moneyers. 11. The blanchers, who anneal and cleanse the money. 12. The moneyers; some of whom forge the money, some share it, some round and mill it, and some stamp and coin it. 13. The porters, who keep the gate of the mint.

Mint, was also a pretended place of privilege, in Southwark, near the King's Bench, put down by statute. If any persons, within the limits of the mint, shall obstruct any officer in the serving of any writ or process, &c. or assault any person therein, so as he receive any bodily hurt, the offender shall be guilty of felony, and be transported to the plantations, &c. stat. 9. Geo. I.

*Process of Coining at the Royal Mint.*—The process of melting silver, at the royal mint, is a recent invention, and a very great improvement. The usual mode was to melt it into black lead pots, and a considerable coinage of tokens for the Bank of Ireland was performed with the meltings done in this way. The importations being entirely Spanish dollars, and the tokens of that standard, the melter could easily melt them in quantities of 60lbs. troy, which was done. The inconvenience of this mode was severely felt, because ingots of silver of various qualities could not be imported for coinage, from the difficulty of not being able to blend several together in one pot, so as to produce the proper standard of our money. So sensible was government of this imperfection in the mint, that in the year 1777, Mr. Alchorne, then master's assay-master, was sent to visit the mints of Paris, Rouen, Lille, and Brussels, and to collect information as to the arts of coining practised in those mints, and particularly the art of melting silver in large quantities. Alchorne's intimate knowledge of the English mint, together with his extensive knowledge as a practical chemist, well fitted him for the undertaking; and his observations on the coin and coinage of France and Flanders are creditable to both his judgment and knowledge.

It is worthy of remark, that it is on record in the books of the mint, that in the recoinage of William III. the pots of silver weighed 400 pounds troy and upwards; but every trace as to how this quantity of silver was melted is completely lost; and it is only conjectured that it was done in pots made of wrought iron. But not a vestige of a melting furnace, fitted for such a purpose, is to be found in the Tower, nor a single record of the method then practised.

In 1758 some trials for melting silver in wrought iron pots took place, by means of a blast furnace; but they were found so laborious, inconvenient, and profitless, as to cause the process to be abandoned. In 1787, when some silver was imported into the mint for coinage, new experiments were made by the late deputy master and worker, Mr. Morrison, who conducted the meltings. A blast furnace was again tried and abandoned. He next attempted to melt the silver in large black lead pots, containing from 100 to 120lbs. troy; but the repeated breaking of the pots, although it was attempted to guard them by outside luting, proved a great interruption to the business, and serious loss to the melter. Trial, indeed, was made with cast-iron pots, but these were found subject to melt, and the iron got mixed with the silver. The work too was continually stopped by the king's assayer, in consequence of the metal not being of the proper standard, it being always refined by the process of melting, and lading it with ladles from the pot.

Independently of these considerations, great difficulty arose at the office in arranging the potting previous to the operation. The practice pursued at the mint to reduce the metal to standard, of combining and blending the various ingots of better and inferior qualities, adding what little portion of alloy or fine metal might be necessary to obtain accuracy, rendered it impossible, where the ingots weighed from 60 to 80lbs. troy, to put them of a weight not exceeding 100lbs. It therefore became necessary, in the first place, to reduce the larger description of ingots to a smaller size by melting, and these were again weighed in the office of receipt. Hence a double operation took place, occasioning additional labour, waste, and expense to the melter, and requiring extraordinary trouble and attendance on the part of the office. It was very obvious that this mode of conducting the silver meltings was extremely defective, and was in consequence abandoned. The next experiments made were with a reverberatory furnace, built after the model of those used in the Lille mint. But no better success attended these trials, and the process was, as in former cases, abandoned. The imperfection here arose from the great refinement of the silver in the melting, by the oxidation of the alloy, and which the usage of the British mint does not allow the melter to supply, as in the French mints. In the French mints, as soon as the silver is in fusion, a sample is taken out and assayed, and copper is added in the proportion to the refinement of the melted silver, (which is kept in fusion while the assay is making;) the whole is well stirred, and immediately laded out and cast into bars. In 1795 and 1798, several farther trials were made by Morrison, who was indefatigable in his endeavours to perfect his department, with a view to attain the object so much desired—that of melting large quantities of silver at once, without producing so much waste and refinement in the metal. In these experiments he tried three furnaces, each of a different construction; and though he was much nearer his point, there was still an imperfection, arising from the mode of dipping out the metal from the pot with ladles, which chilled the metal, and rendered the process extremely laborious and tedious.

No new experiments were made until the year 1804. Mr. Morrison having died in 1803, was succeeded by his son in the office of deputy master and worker of the mint. The extreme scarcity and defective state of the silver coin at this time, arising from the defective state of the melting department, urged Morrison to renew the experiments of his father. In following these experiments, Mr. Morrison had in view the construction of a furnace adapted for the use of cast iron pots, the use of pots of a size capable of melting from 400 to 500lbs. troy, at one charge—the adaption of such machinery as would supersede the clumsy and wasteful process of lading the silver from the pots when melted—and lastly, the introduction of the use of moulds made of cast-iron, in place of those then used in the mint, and which were made of sand. In all these objects Mr. Morrison, highly to his credit, perfectly succeeded; and the silver melting department of the new mint was constructed according to the furnace first used in the experiments which led to such a satisfactory result. The whole has been in use since 1811, and the department is capable of melting, with ease, 10,000 lbs. troy of silver daily, as was done for several months during the late recoinage (1817). Before we give a description of the apparatus for flatting, rolling, or laminating the silver, we shall proceed to describe the machinery and furnaces of the silver melting department.

The engraving illustrative of this article exhibits a perspective view of the machine for casting ingots of silver.

In the plate, fig. 1, A A are the furnaces in which the metal is melted. These are the air furnaces, built of fire brick, in the usual manner of melting furnaces; but to render them more durable, the brick work is cased in cast-iron plates, which are put together with screws. B B are the covers to the furnace; they are held down to the top plate of the furnaces by a single screw pin for each; and on the opposite side of the cover, a handle *a* is fixed. By pushing this handle, the cover is moved sideways upon its centre pin, so as to remove it from the furnace mouth. A roller is fitted to the cover, to run upon the top plate and render the motion easy.

The interior figure of each furnace is circular, 30 inches deep, and 21 in diameter; the bottom is a grate of cast iron bars (each bar being moveable) to admit the air. Upon the grate is placed a pedestal or stand of cast-iron, of a concave shape, covered an inch thick with coke or charcoal dust, and upon which the pot is placed in which the silver is melted. The pedestal is nearly two inches thick, and is fully two inches broader in diameter than the pot, the object of which is to protect the hip of the pot from the very high heat which the current of air, ascending through the grate, when the furnace is at work, creates, and which would otherwise melt the pot. This precaution is essentially necessary, from the pedestal raising the pot so considerably above the grate, and from its being entirely surrounded by the fire in the furnace. If the furnace, however, is properly managed, there is no risk of melting the pot. On the top or mouth of the pot is placed a muffle, which is a ring of cast iron six inches deep, made to fit neatly into the mouth of the pot; the use of this muffle is similar to that used in melting, gold to give a greater depth of fuel in the furnace than the mere length of the pot, and which gives a greater degree of perfection to the process. The muffle is also extremely convenient, by giving a depth to the pot, if we may so speak, which enables ingots of silver to be charged, which are longer than the depth of the interior of the pot. The top of the ring or muffle is covered with a plate of cast iron, to prevent the fuel from falling into the pot, and secure the metal from the action of the atmospheric air when in fusion. Each furnace has a flue nine inches wide and six inches deep. The flue is four inches from the top of the furnace, and proceeds in a horizontal direction, and extends to the flue C, which is nine inches square, and is carried up in a sloping direction to the stack or chimney, which is 45 feet high from the grate of the furnace.

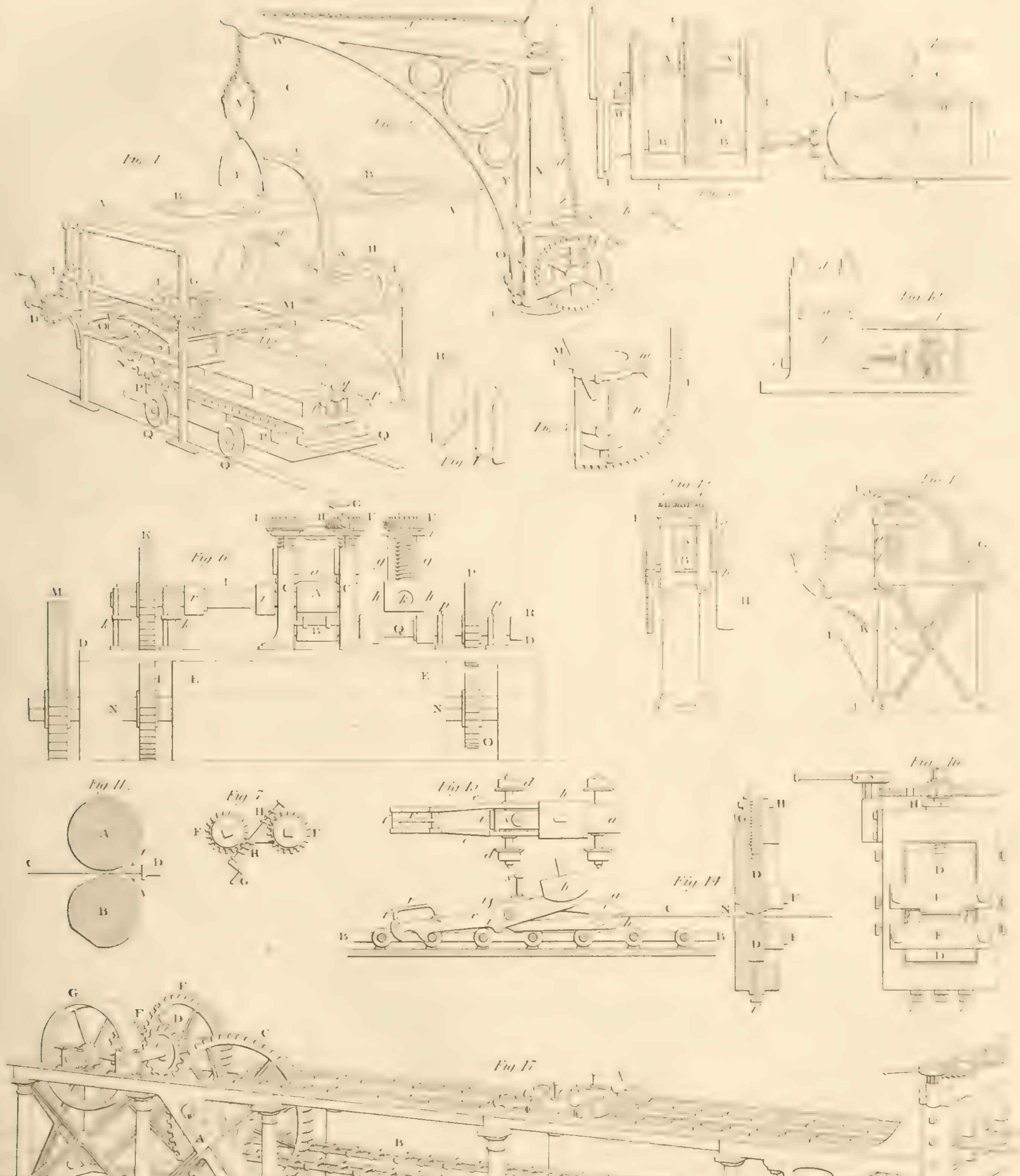
When the furnace doors, B B, are closed, the current of air which enters at the grate ascends through the body of the furnace, and causes the fuel, which is coke, and which surrounds the melting pot, to burn very intensely. The degree of heat wanted, however, is very nicely regulated by a damper, which is fixed in the flue of each furnace, and exactly fitting the square of the flue, so that any portion of draught can be given to the furnace that may be wanted. The damper is a plate of wrought iron, fixed in a frame, and is easily moved in and out, so as to increase or diminish the size of the flue. It is fixed in the brick-work of the sloping flue C, about 18 inches above the top of the furnace. The furnace doors B have small holes in them to look into the furnace: these are closed by stoppers or plugs of cast iron. When the furnace is put to work, it is lighted by some ignited charcoal being put upon the grate and around the pot (for the pot is always in its place before the fire is lighted); upon the charcoal about three inches deep of coke is put; the door B is shut, and the damper is pulled out about two inches. When the coke is ignited, a similar quantity is put on, and so continued until the furnace is filled with ignited coke. The object of this precaution is to prevent the cracking of the cast iron pot by being too suddenly heated; and it is generally about two hours before the pot can be brought to a charging heat, to do it with perfect safety. Before the silver is charged, the pot is heated a bright red; it is then examined to see if it has cracked in bringing up, as it is technically called. This is done by placing a cold iron tool of considerable thickness in the centre of the pot, which immediately renders any crack visible to the eye. When satisfied that the pot is sound, the silver is charged into the pot. With the silver is put into the pot a small quantity of coarsely grained charcoal powder, which coats the inner surface of the pot, and prevents the silver from adhering to it. When the silver is brought to the fusing point, the quantity of charcoal is increased, until it is nearly half an inch deep on the surface of the silver, and which keeps the silver as much as possible from the action of the common air, and prevents that destruction of the alloy which would otherwise cause a considerable refinement in the metal. When the silver is completely and properly melted, it is well stirred with an iron stirrer, so as to make the whole mass of one uniform standard quality. The pot is then taken out of the furnace by the crane, and conveyed to the pouring machine, by which its contents are poured into the ingot moulds.

Fig. 2, is the crane, it is supported by a strong column of cast-iron, X, which is firmly fixed in masonry beneath the floor. The gibbet of the crane marked W Y, is cast in one piece; it has a collar at *e*, which fits upon a pivot formed at the upper end of the column X. At the lower part of the gib is a collar which embraces the column near its base. On these two supports the gib turns freely round, so that its extremity W may be placed over either of the furnaces B B. The wheel work of the crane is supported in two frames *z z*, which are fixed to the gib by three bolts; it consists of a cog wheel *c* upon the end of the barrel, on which the chain winds; and a pinion *b*, which gives motion to the cog wheel. The axis of the pinion has a winch or handle, *a*, at each end, to turn it round. The chain *d*, from the barrel, is carried up over the pulley at *c*, which is fitted in a part of the gib immediately over the pivot at the top of the column X. The chain then passes over the pulley W, at the end of the gib, and has the tongs V T suspended to it. These are adapted to take up the pot between the hooks or claws T, at the lower ends. The two limbs are united by a joint like shears, and the upper ends V are connected with a great chain by a few links. The pot has a projecting rim round the edge, and the tongs take this rim to lift the pot out of the furnace. The pot being wound round to the required height by turning the handle *a*, the gib of the crane is swung round, to bring the pot over the pouring machine, and it is lowered down into it, for the convenience of swinging the crane round a worm which is fixed upon the column X at O, and a worm or endless screw is mounted in the frame *z*, to work in the teeth of the wheel. The screw, being turned by a winch on the end of its spindle, will cause the gib to move round on the column.

Fig. 3 of the engraving represents that part of the pouring machine in which the pot is placed; *m* is an axis, which is mounted in the frame of fig. 1, by the pivots at its ends. To this axis is fixed a cradle, which receives the pot. The cradle is joined together so as to open and shut, and the screw *m* draws the parts together until they fit. To the pot *n* there is fixed an arched rack L, forming a continuation of the principal bars of the cradle. When the cradle is in its place, as in fig. 1, the rack L is engaged by a pinion K, and can thereby be elevated to pour out the metal at a lip or spout, which is made at the edge of the pot for the purpose. The axis of the pinion K is turned by means of the winch D, with a train of wheels, D, E; F, G; I, H; and K. The man who turns this winch stands before the pot, so as to see what he is doing. The frame of the pouring machine is sufficiently evident from the figure. It is so made as to leave an open space beneath for the carriage, fig. 5, containing the ingot moulds.

Fig. 4, is a separate view of a pair of ingot moulds, the two parts, R and S, put together and form a complete mould, as shewn in fig. 5. The upper edge of the mouth is a little enlarged, to facilitate the pouring of the metal. The moulds are made of cast-iron. The part R has the bottom

The Forging of Cannon at the Royal [illegible] [illegible]



and one side formed on it, and the other half, S, has one side formed on it. Before the moulds are used, they are heated in an iron closet, which has flues surrounding it, and they are then rubbed on the inside with linseed oil.

P Q, fig. 1, is the carriage into which a row of these moulds is placed, as shewn at 4, and they are screwed up close by two screws *p p*, so as to hold them tight; the moulds rest upon a plate which is suspended by screws *q*, at each end, and can by that means be raised or lowered to suit different heights of moulds. The carriage is supported on four wheels Q Q, which run upon a railway. P P is a rack fixed to the bottom plate of the carriage; in this rack, a cog-wheel N acts; the cog-wheel is turned by a pinion, which has a handle or winch O, fixed upon it; by turning the handle, the carriage is moved along the railway; and any one of the moulds, fig. 4 or 5, can be brought under the spout of the pot, fig. 3; then by turning the handle D, fig. 1, the pot can be inclined so as to pour the metal into the mould until it is full.

In the silver melting-house there are eight melting furnaces, two cranes, and two pouring machines. Each crane stands in the centre of four furnaces, freely commanding the centre of each, and conveys the pots to the pouring machine. The eight furnaces are worked three times daily, and each pot contains, upon an average, 420lbs. troy, making the total melting 10,080 lbs. There are four men to each four furnaces; each party pour their own pots, and the whole meltings are finished, from the time of first charging in the morning, in little more than ten hours. The whole of the silver meltings are conducted under the superintendence of the surveyor of the meltings; and he allows no silver to be delivered to the company of moneyers by the melter, unless he has a written order from the king's assay master, authorizing such delivery.

The meltings are performed by contract with the master of the mint, and his first clerk, as melter. He is responsible to the master for all the bullion he receives, and delivers weight for weight, which renders his situation one of considerable risk and great responsibility. He also finds security for the due performance of the duties of his office. The bars of silver, of the approved standard, are delivered over to the moneyers, who perform the various processes of the coinage under contract with the master of the mint, always delivering weight for weight. They also give security for the due performance of the duties of their office.

*Laminating Rollers employed at the Royal Mint.*—The first process to which the silver bars issued from the silver melting department of the royal mint, is subjected, is that of flatting, rolling, or laminating in the rolling mill. The bars, before they are put through the rollers, are heated to redness, which makes them much easier rolled. They are heated in a reverberatory furnace. When the gold bars are subjected to the same process they are rolled cold, and a bar of an inch thick can be reduced to the thickness of a half-sovereign, without ever being annealed, and could be reduced much thinner if necessary, and not shew the least symptom of cracking.

The drawing (see the plate, fig. 6,) is an elevation of one pair of rollers, and the wheel-work for giving motion to them. A is the upper and B the lower roller; C C are the standards of the cast-iron frame which supports them. Each of these standards has an opening in it to receive the bearing brasses for the pivots of the rollers. The upper roller is suspended in brasses, which are regulated by the large screws F, F, which admit of placing the rollers at a greater or less distance asunder. This is shewn by the separate figure of one of the screws; *h h* are the brasses, and *k* the hole to receive the pivot of the roller. On the upper part of the screw a collar *f* is fitted; and from this two bolts *g g* descend, and are fastened to the brasses *h h*, with nuts beneath. By these the roller is suspended, but by turning the screw round, the brasses rise or fall; the brasses *h h* are fitted very accurately into the grooves or openings into the standard C C. For the convenience of turning both screws round together, each has a cog-wheel F fixed on the upper end of it. These are turned by two worms H H, fig. 7, fixed on a common axis, which has a handle G in front: by turning this handle the upper roller is either raised or lowered, as is required, but will always be parallel to the lower one. The two standards C C are firmly bolted down to the ground-sills D D, which are of cast-iron, and are bedded in the masonry E E. The standards are further united by bolts *a*. At the upper part is a cross bar, fixed between the standards, to support a small table or platform, on which the metal is placed when it is to be presented to the rollers. The rollers are put in motion by a steam-engine. The crank of the engine has a cog-wheel upon it, which turns a pinion. Upon the axis of this is a very heavy fly-wheel, which turns with great velocity. On the end of the same axis is a pinion which turns a large wheel M, and this gives motion to a large shaft N N, which extends beneath the rollers, and is continued a sufficient distance in the same direction, to turn two pairs of rollers, one of which only is represented in the drawing. At L a wheel is fixed on this shaft, to turn the upper roller A, by means of a wheel K, which is supported in the standards *k k*, and its axis is connected with a short shaft *r* I *r*, with the square on the end of the roller A; *r r* are the sockets by which the shafts are joined, and they admit of a little yielding when the roller is raised. The wheel O is fixed on the shaft N, to turn the lower roller B, by means of the wheel P; but the wheels P and O do not touch, being of smaller diameters, and an intermediate wheel is also applied on one side, so that its teeth engage with both the wheels O and P; by this means, the two rollers A and B are made to turn round in opposite directions, and then their adjacent surfaces will move together. The wheel P is supported in standards *p p*, and its axis R connected by a shaft Q, with the lower roller B. There is also a gauge to ascertain the thickness of the plates which are reduced by the operation of the rollers; it consists of two steel rulers fixed fast together at one end, and the other end is a certain distance asunder, forming an opening between them, which gradually diminishes to nothing: the sides of the rulers are divided. In using this gauge to determine the thickness of a piece of plate, the edge of the plate is applied to the opening between the rollers, and the divisions of the rollers shew the distance it will go into the opening before it fits tight; and the thickness is ascertained by the number of the divisions.

We now proceed to describe the machine by which the plates of metal from the rolling mill are cut into slips of a convenient width, for cutting out the circular pieces or blanks which are to form the coin. This width is generally that of two crowns, two half-crowns, and shillings.

Figs. 8 and 9, in the plate, are representations of the cutting machine. L L is a strong iron frame, which is screwed down to the ground-sills of the mill, so that the cog-wheel D will be immediately over the shaft which turns the rolling-mill, and can be turned by a cog-wheel upon that shaft. The cog-wheel D is fixed upon an horizontal axis B B, which is supported in the frame L L. A A is a similar axis placed at the top of the frame, and turned round by a cog-wheel C, which engages with the wheel D. On the extreme end of each axis A and B, a wheel or circular cutter E and F, is fixed. The edges of these cutters lie in close contact laterally, and overlap each other a little. The edges of the cutters are made of steel hardened, and they are turned very truly circular, and the edges which overlap are made very true and square. Whilst they are turning round, if the edge of any piece of metal be presented to them, it will be cut or divided just in the same manner as by a pair of shears. H is a narrow shelf, upon which the plate is supported when it is pushed forwards to be cut, and G is a guide fixed upon the shelf; the edge of the plate of metal is applied against this guide, whilst it is moved forward to the cutters. The guide is moveable, and the distance which it stands back from the cutting edges, or line of contact of the two cutters E F, determines the breadth of the slip of metal which will be cut off. Fig. 9 is another view of fig. 8.

To give these slips of metal the exact thickness which is requisite before they are cut up into blocks, they are subjected to a more delicate rolling; or they are drawn between dies by a machine, invented by Mr. Barton, the present comptroller of the mint.

Figure 10 represents the finishing rollers, viewed at the end of the frame, in order to shew the manner of adjusting them; for it is only in those parts that they differ from the great rollers; *a* is one of the pivots or centres of the upper roller; and is accurately fitted in a collar of brasses, which collar is held down in a cell at the top of the standard by a cap *d*, with two bolts and nuts. These are not intended for the adjustment of the rollers, as in the former instance, but the lower roller is moved for this purpose. The pivot *b* of the lower roller is received in a brass bearing, which is moveable in the opening in the standard frame. The brass rests upon a wedge *c*, which is fitted in a cross mortise through the standard. By forcing the brass farther in the wedge of the lower roller, it will be moved nearer to the upper roller. The standard at the other end of the rollers is made in the same manner, and the wedges of both must be moved at the same time. To give them motion, a screw *f* is fitted into each wedge, and upon these screws are worm wheels *g*, which are both moved by worms cut upon an horizontal axis, that extends across from one end of the frame to the other, and has a handle at the end to turn it round by, and move the screws and wedges both in equal quantity; *l* is the table on which the metal is laid to present it to the rollers.

The following engravings are descriptive of a new machine, invented by Mr. Barton, and employed at the royal mint for drawing the slips of metal between dies, by which a greater degree of accuracy and uniformity is obtained in the thickness of the metal. The operation is similar to wire-drawing.

The 11th, 12th, and 13th figures, represent a small machine for thinning the ends of the slips of metal, so that they will enter into the dies through which the whole of the slip is to be drawn. It is a small pair of rollers, which are shewn on a large scale in fig. 11. A is the upper roller, and B the lower; this has three flat sides, as represented; C is the slip of metal put between the rollers; D is a stop, adjustable in the line of the motion of the slip of metal C. The twelfth figure is an end view, and the 13th a side view, of the frame or machine in which the rollers are mounted. A, B are the rollers, which are made to turn together by pinions *a*, *b*. F is a large cog-wheel, which is fixed on the end of the axis of the lower roller. This cog-wheel is turned by a pinion G, which is fixed on an axis extending across the machine, and having a fly-wheel fixed on one end, and at the other a drum H, to receive an endless strap, by which the machine is put in motion; a crank is formed on the middle of this axis, and a rod *d*, is joined to the crank, to connect it with the moving blade K of a pair of shears, of which the other blade L is fixed to the frame. The distance of the rollers is regulated by a screw *e e*, at the top of each standard. These screws have pinions at the top of them, and are turned round by a pinion, which is placed between them, and engages the teeth of both pinions, so as to give motion to the two screws at the same time, when the middle wheel is turned round by a cross handle, which is fixed to the top of it. If the slips of metal which are to be put into this machine are not exactly square at the ends, they are cut off smooth and square by the shears, which keep constantly moving; the end of the slip is then presented between the rollers, not on that side which would draw them in between the rollers, as in common rolling, but on the opposite side; when one of the flat sides of the lower roller comes opposite the upper roller, then the piece of metal can be pushed forwards between the two, until the end stops against the stop D, as in fig. 11; then as the rollers turn round, and the flat side of the lower roller passes by, the cylindrical parts of the roller will take the metal between, and roll it thinner at the end which is between the stops and the point of contact of the rollers.

Figs. 14 and 15. Fig. 14 is a section, to shew how the slip of metal C is drawn between the dies by the tongs, of which fig. 15 is a sort of ground plan. The dies are two steel cylinders made very hard, and extremely true; fitted into two sliders D, D, and held fast by clamp pieces screwed against them. The cylinders are accurately fitted into their beds in the slides, so that the steel shall be firmly supported, and prevented from bending or turning round, and to present but a small portion of their circumference against the slip of metal. The sliders D, D are fitted into a box, figs. 14 and 16; they fit flat on the bottom of the box, and two clamps F, F are screwed against the sliders, to confine them to the box. The lower slider is supported by two screws, *f*, *f*, and the upper side is forced down by a large screw G; this has a cog-wheel fixed on the top of it, with a pinion and lever to turn the screws round very slowly, and regulate the distance between the dies. H is a clamping nut, fitted upon the screw, to take off all possibility of shake; the sliders also are bound fast sideways by screws tapped through the sides of the box, the points of which press upon steel plates between them and the sliders. In order to render the contact between the points of the screws supporting the under side, and the point of the adjusting screw, forcing the upper slider, still more complete, two extending screws are introduced at the ends of the steel dies between the sliders, by which a sufficient degree of contact to overcome the spring of the materials may be excited, before the dies come into action on the slip of the metal, fig. 15.

*Rolling Machine.* The box of dies, fig. 17, is fixed at one end of a long frame. This frame supports two axes A A, one at each end. Upon these axes wheels are fixed, to receive endless chains B B, which move along a sort of trough or railway, formed on the top of the frame. The chains are kept in motion by a cog-wheel C, which is fixed upon the axis most remote from the box of dies. This cog-wheel is turned by a pinion D, on the axis of which is a wheel E; and this wheel is turned by a pinion F on the axis of the drum G, which is moved by an endless band, proceeding from some of the wheels in the mill, and which is thrown in and out of geer at pleasure by a tightening roller. The slip of metal is drawn through the dies by the chain, with a pair of tongs.

Figs. 14 and 15—*a b* are the two jaws of the tongs, which are united with each other by the joint pin *c*. This has fitted on each, a small roller or wheel, which runs upon the railway or top of the frame; *d d*, fig. 15, are a similar pair of wheels, the axle of which is connected with two links *e e*; this axle passes between the tails of the tongs, but is not fixed to them. The ends of the links have a double hook formed on them, as shewn at fig. 15. The tongs run upon their wheels immediately over the endless chain, so that when the end of the links *ee* is pressed down, one of the hooks catches on a cross pin of the chain, as in fig. 15; the axle of the wheel *dd* acting between the inclined parts of the tails of the tongs, tends to throw them asunder, and, at the same time, the jaws of the tongs bite with very great force; the links *e e* draw the tongs along with the chain B B. The links are carried a long way beyond the axle of the wheels, and have a sufficient weight *h* fastened to them, which will lift up the hooked end *f*, and disengage it from the chain, except when there is a considerable strain on the tongs.

To use this machine, a boy takes hold of the tongs by the handle *r*, when they are disengaged from the chain, and pushes the tongs forward to the box of dies. The tongs run freely upon their wheels, and the jaws open when moved in that direction, because two small pins *i i*, are fixed between the links, and acting on the outsides of the tails of the tongs, close them together, and this at the same time opens the jaws. The tongs are pushed up close to the box of dies, and the jaws enter into a recess N, fig. 14, which is formed for that purpose. Another boy takes a slip of metal, which is previously made thin by the rollers, fig. 11, and introduces it between the dies, and also between the jaws of the tongs, which are open. The boy who holds the tongs now takes the handle *s*, which is fixed on the back of the tongs, and holds it fast, whilst with the other hand he draws the handle *r*, at the end of the links, away from the tongs. This has the effect of closing the jaws of the tongs upon the slip of metal between them; at the same time the boy depresses the handle *r*, and the hook at the end of the links *e e* will be caught by the first cross-pin of the chain which comes beneath them. This puts the tongs in motion; but the first action is to close the jaws, and bite the piece of metal with great force, in consequence of the axletree of the wheels being placed between the inclined planes of the tongs. When the tongs have closed on the metal with all their force, they move with the chain, and draw the slips of metal through the dies, which, operating upon the thicker part of the slip with greater effect than upon the thin, reduces the whole to an equable thickness. When the whole is drawn through, the strain upon the tongs is gradually released; and the weight lifting up the hook at the other end of the links, they are ready to be advanced again to the die, to draw another bar. The frame, of which we have given a drawing, contains two pair of dies, and the same wheel serves for both. At the mint there are two

# Process of Coining at the Royal Mint.

Fig. 1

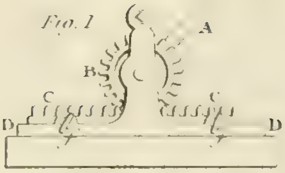


Fig. 2

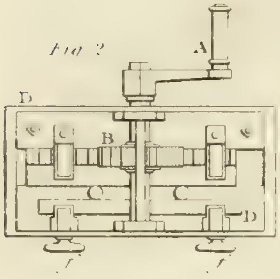


Fig. 3.

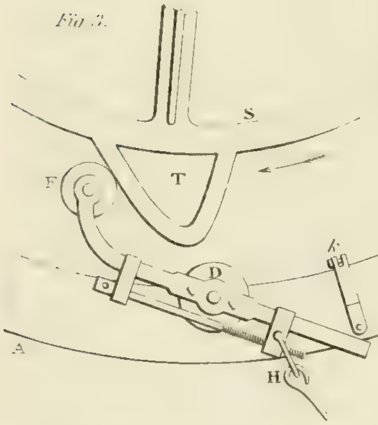
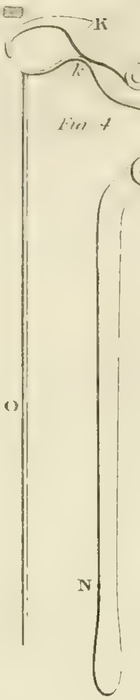


Fig. 4



Coining Press.

Fig. 5.

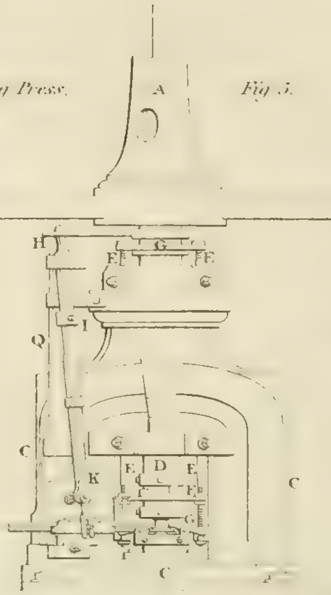


Fig. 9.

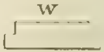


Fig. 6.

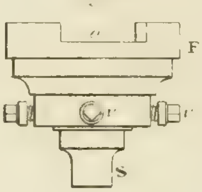


Fig. 7

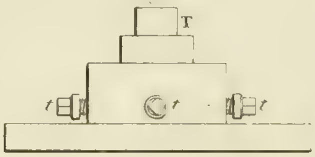


Fig. 10

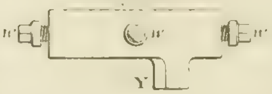


Fig. 11

Fig. 8

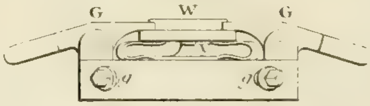
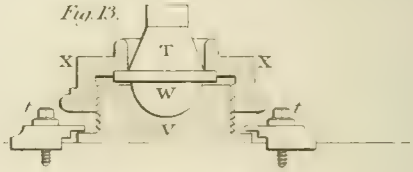


Fig. 13.



Bolton's cutting out Press

Fig. 12.

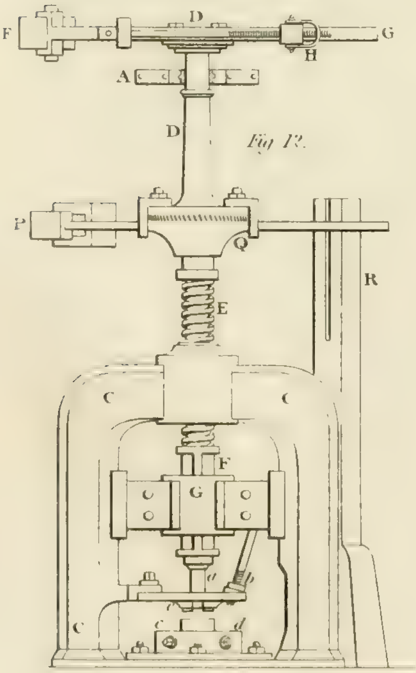


Fig. 14

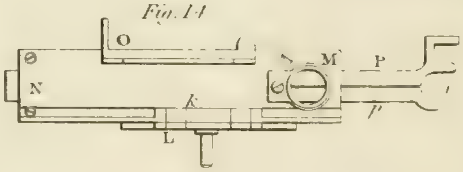


Fig. 17

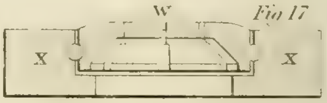


Fig. 15

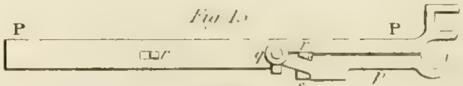


Fig. 16

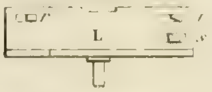


Fig. 18

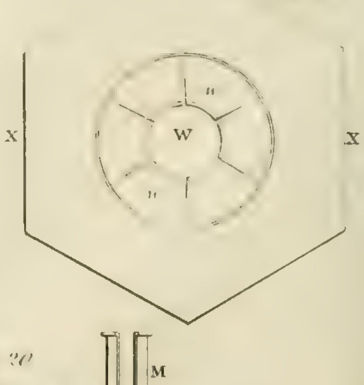


Fig. 19

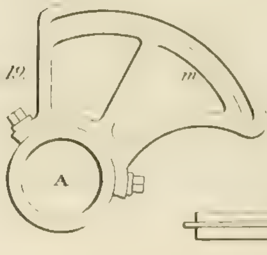
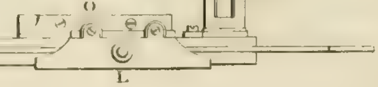


Fig. 20



machines of this description; they are placed side by side, with a sufficient space for the boys to work between them. These machines were made by Mr. Maudsley, under the direction of the inventor. The slips of metal produced from this machine are considerably more uniform in thickness than when finished at the adjusting rollers; consequently, the individual pieces are made more nearly to the standard weight, which was the object in view by this invention. This has become a point of great importance in the practice of the mint, from the remedy on gold in weight being reduced from 40 to 12 troy grains. When the pieces cut from slips of metal, prepared from the drawing machine, are pounded and weighed, which is telling the number of pieces in a pound troy, sovereigns or half sovereigns, the variations from standard either way seldom exceed three grains troy. It is reckoned good work from the adjusting rollers when the variations are under six troy grains.

*Adjusting.* The blanks, after being cut out by Bolton's cutting-out press, are carried to the sizing room, where each individual piece is adjusted to its standard weight. The light pieces are selected for remelting, and the heavy ones, if not considerably beyond weight, are reduced to their standard weight by rasping their surfaces with a coarse rasp or file. The superior accuracy of Mr. Barton's beautiful machine (described above) has considerably abridged the labour of this inelegant and unmechanical process. The pieces thus adjusted are in a state of great hardness, from compression by the rolling and drawing processes, and by which, in fact, their latent heat has been squeezed out. They attain their softness again by being heated to a cherry red heat in a reverbatory furnace; after which they are boiled in a very weak sulphuric acid, which makes them very clean, and of a very white colour. When dried, either in warm sawdust, or over a very slow fire, they are in a state for the two next processes, which are the milling, and the coining or stamping.

*Milling.* Plate II. The operation of milling is to be performed round the edge, to prevent their being clipped or filed, which was a fraud commonly practised upon the ancient money made before the introduction of milling or lettering round the edge. The construction of the milling machine will be easily understood, from the inspection of figs. 1 and 2, being an elevation and plan of the same. The parts which operate upon the piece of money, consist of two steel bars or rulers D D, the adjacent edges of which are cut or fluted; the lower bar, seen in plan fig. 2, is immoveable, being fastened down by two clamps to a cast-iron plate D, forming the base of the whole machine; the upper bar is prevented from rising by the two vertical pieces, but has the liberty of moving backwards and forwards in the direction of its length, and is guided in such motion by laying half its thickness in a groove formed in the plate D. A rack, C C, fig. 1, is fixed to the moving ruler, which engages in the teeth of the wheel B, mounted on an axis lying across at right angles to the ruler, and supported at its ends by two standards rising up from the plate D. On one end of the axis a handle is fixed for giving motion to the machine. Two blanks are put into the machine at the same time, as seen in the second figure, and the lower ruler can be made to approach nearer to, or recede farther from, the upper ruler, by the two screws *f f*, to take in a different sized piece between them. The operation of the machine is very simple. Two blanks being placed between the edges of the rulers, the handle A is turned round half a turn, which moves the upper ruler endways, sufficient to mark the blank all round the edge. The two milled pieces are then taken out, and two other blanks are placed between the rulers; the handle A being turned half round in an opposite direction, carries the upper ruler back again to the position in which it first stood; thus two more blanks are milled, and so on. The machine is placed upon a strong wooden bench, to raise it to a convenient height for the man who turns the handle; the blanks are placed in the machine by a boy, near to that where the handle is.

The 3d and 4th figures on Plate II. are further illustrations of Bolton's cutting-out press. Fig. 3 shews the manner of the horizontal wheel acting on the roller F. It represents a horizontal plan of the upper part of the axis. S, fig. 3, is part of the rim of the large wheel, and T, one of the projecting cogs, which, when the wheel turns in the direction of the arrow, will take the roller F, at the end of the lever F D, and turn the lever round in that direction which will wind up the screw, and raise the punch out of the die. This action also draws a rod H, which is connected with the lever by a joint; the other end is connected with a bended lever, from the other end of which a rod descends, and has a piston fixed to it. Fig. 4 is the catch. At K it is moveable on a joint E, and is thrown upward by a spring *k*. To this spring a cord O is fastened, and the lower end of the cord has a treadle fastened to it. For a perspective view of Barton's Rolling Machine, see the plate.

*Coining Press.*—We now proceed to give a description of the Coining Press, an elevation of which is exhibited in fig. 5, in the Plate. C C C is a strong cast-iron frame, screwed down on a stone basement; the upper part is perforated perpendicularly, to receive the screw, D. One of the steel dies which strike the coin, is fixed to the lower end of this screw by a box, fig. 6, and the other die is fixed in a box, fig. 7, which is fastened down upon the base of the press. The heavy balance weights, R R, fig. 5, are fixed on the top of the screw, which, being turned round, press the upper die down upon the blank piece of coin, which is laid upon the lower die, and gives the impression; a sufficient force being obtained from the momentum of the loaded arms, R R. The motion is communicated to the screw by a piece, A, which ascends to the ceiling of the coining-room, and is worked by a steam-engine, with machinery, in the apartment in the room over the coining-room.

Eight presses, similar to this, are placed in a row upon the stone basement, and very strong oak pillars are erected upon the basement, and reach to the ceiling. Each press is contained between four such pillars, and iron braces are fixed horizontally from one pillar to another on the opposite side. These braces support blocks of wood, against which the ends, R R, of the arms strike, to stop them from moving farther than necessary, as, without such precaution, the hard steel dies would sometimes come in contact, and be broken. The piece of blank coin is contained within a steel ring or collar, whilst it is stamped, and this preserves its circular figure. The ring is shewn at a large size at W, fig. 9. V, fig. 8, is a three-pronged spring, which always bears the spring upwards; the opening through the ring, W, is made to fit upon the neck of the lower die, T, fig. 7. When the ring is dropped upon the neck of the die, the upper surface of the ring and of the die will be in one plane. The ring admits of being raised up upon the neck, and will then form a recess or cell, which is just adapted to receive a piece of money. The collar, W, is made to rise and fall upon the neck of the die by means of the levers, G G, fig. 8; these are fitted upon centre-pins or joints, in a large ring, *g g*, which is placed on the outside of the box, fig. 7, containing the lower die, T, and is fixed fast upon it, as shewn in fig. 5, by clamping the screws, *g g*. The levers, G G, are forked at the outer ends, to admit studs at the lower ends of iron rods, E E, which rise up through holes in the solid metal of the press, and are united to a collar, G, fitted on the upper part of the screw, D. When the screw of the press is turned back, and the upper die is raised up, the rods raise the outside ends of the short levers, G, and the inside depresses the ring; a blank piece of money is laid upon the die, and when the screw is turned to bring the upper die down upon it, ready to stamp the impression, the levers, G, are released, and the triple spring, V, lifts the collar up, so that it surrounds the piece of money; and in this state the blow is struck. Immediately after, the press returns by its recoil, and then the levers, G, force the collar down upon the neck of the die, and leave the piece free. The lower die is fixed in a box, fig. 7, by the screws, *t t*, which admit of adjusting it with precision beneath the upper die. The box, fig. 7, is screwed down upon the base of the press by four screws. The upper die is shewn at S, fig. 6, which explains how it is fastened to the screw; *v v* are four screws, by which the die is held in a box, fig. 6. The box is fitted into a ring or collar, as shewn by the dotted lines, F; see also fig. 5. The arms of the collar, F, are attached to the rods, E E, by two nuts at each end; and this makes the collar, F, and the box, fig. 11, always follow the screw, and keep in close contact with the end of the screw, which enters into a cell on the top of the box, fig. 6, but leaves the screw at liberty to turn round independently of the box.

Fig. 2, is a ring, which is fastened by its screws, *w w*, to the screw of the press; a claw, Y, descends from the ring, and enters into the cavity, *o*, in the edge of the box, fig. 6, which cavity is nearly three times as wide as the claw, Y, and therefore allows the screw to turn round for a certain distance without turning the box, fig. 6; but beyond the limits of this motion the screw and the die will turn round together. The intention of this is to press the upper die down upon the coin with a twisting or screwing motion; but if the die was to rise up with a similar motion, it would abrade and destroy the fine impression; for this reason the notch, *o*, is so wide as to allow the screw to return, and raise the die from immediate contact with the coin, before it shall begin to turn round with the same motion as the screw.

Fig. 11, is a box, which is screwed over the box for the upper die, as shewn in fig. 1, in order to keep the upper die firm in its cell. The great screw of the press is made cylindrical at the upper and lower ends, as represented in fig. 5, and their ends are accurately fitted in collars, which are bound tight by screws, the real screw or worm is partly concealed within the solid metal frame, and has no other office than to force the die down, the guidance laterally being effected by the collars.

It now only remains to shew how the Coining Press is made to remove every piece of money which it strikes, and to feed itself with a fresh blank piece.

H I K, fig. 5, is a lever, of which I is the fulcrum; it is supported in a bar, Q, fixed vertically from the cheek of the press, and steadied by a brace. The upper end of the lever is actuated by a sector, which is fixed upon the screw, D. When the screw turns round, the groove in the sector being of a spiral curve, will move the end, H, of the lever, to and from the screw; and the lower end, K, of the lever being longer, it moves a considerable distance to and from the centre of the press. A socket or groove in a piece of metal is fixed to the perpendicular bar, Q, and the upper end of the lever, H, is guided in this groove to prevent any lateral deviation.

The lever K, gives motion to a slider, L, fig. 20, which is supported in a socket, O, screwed against the inside cheek of the press; and the slider 20, is directed exactly to the centre of the press, and on the lever of the upper surface of the die.

Figures 14 and 20, represent four views of the slider and socket; N M O, fig. 14, is a kind of trough or socket in which the slider runs: this slider is formed of two pieces hollowed out on the sides, which are put together, and the two pieces are held together by screws. O is the part by which the socket is fastened to the press. The slider is a thin steel plate, *p;* and this is made in two pieces, P and *p*, which are united by the joint *q*, fig. 15. The extreme end is made with a circular cavity; and when the two limbs shut together, they will grasp a piece of money between them, and hold it by the edge; but if the limbs are separated, the piece will drop out. The limb, *p*, of the slider, is opened or shut by the same movement which moves the slider endways in its socket. Thus a plate, L, is applied flat beneath the socket, M N, and has an edge turning up and applying to the upright edge of the socket. A pin is fixed into this edge, and is embraced by the fork at the lower end of the lever, K, fig. 5. By this means the sliding piece, L, is made to move on the outside of the socket, N. It is kept in its place by a fillet, *k*, fig. 14, which is screwed to the upright edge of L, and the fillet enters a groove formed along the upper surface of the socket, N.

The sliding piece, L, is made to move the steel slider within the socket by means of three studs, which project upwards from the bottom plate of L, fig. 16, at *r r*, *s*, and pass through grooves in the bottom plate of the slider, so as to act upon the steel slider, P, in the manner shewn in fig. 15. The left-hand piece, *r*, is received into an opening in the middle of the slider, P, fig. 15. The other two studs, *r* and *s*, fig. 16, include the shank of the limb, *p*, between them, and these studs are cut inclined, so that, when the piece, L, is moved to the right, the studs, *r s*, will close the limb, *p*, until they are shut, and then the studs will carry the slider forward; but, if the sliding piece, L, is moved to the left, its studs will first close the limbs, and will then draw back the slider on the top of the socket, N; a tube, M, is placed, figs. 15 and 20, and it is filled with blank pieces of coin; the tube is open at bottom to the slider, and the pieces rest upon it. When the screw of the press is screwed down the slider, P, draws back to its farthest extent, and the circle formed at the end between its limbs comes exactly beneath the tube, M; the limbs being open, a blank piece of coin drops down into the circle of the slider; then the screw of the press, in returning, moves the lever, H I K, and the piece, L; this acts by its studs upon the moveable limb, *p*, and closes it upon the blank piece; the studs having now found a reaction, push the slider, P, forwards in its socket, and carry the piece forward upon the die, as shewn in fig. 13, and which will push off the piece last struck. The screw having now arrived at its highest position, begins to descend, and the slider, L, to return; but the first action of the studs of the sliding piece, L, is to open the limb, *p*, and then the slider withdraws, leaving the piece of money placed upon the die. As the screw of the press descends, the ring, *w*, rises up to enclose the piece, as before mentioned, whilst it receives the stroke, and the slider, P, at the same time returns to take another piece from the tube, M, in the same manner as before described.

Fig. 13, is a section, to shew the manner of mounting the lower die for a coining press. This is used in the French Mint. V is a piece of metal or box, as it is placed upon the base of the press, and held down by a ring with screws, *t;* this holds it fast, but admits of lateral adjustment. In the top of the box is a hemispherical cavity to receive the hemisphere, W; the upper side is flat, and the die, T, is placed upon it, to hold the die down; it has a small projecting rim at the lower edge, and a rim, X, is screwed upon the outer edge of the box, V, to hold the die down. The object of this plan is, that the die may always bear fairly to the money which it is to strike.

Figures 17 and 18, represent a divided collar, invented by Mr. Droz, for striking money with the letters round the edge. X, fig. 18, is a very strong piece of iron, which has a circular opening through the centre; into this, six segments, *w*, *w*, are fitted, and between them they leave an opening, W, the size of the piece of money; the interior edges of these segments are engraved with the pattern or device which it is required to impress upon the edge of the piece. The segments are fitted in the piece, X, by centre pins, upon one of which pins each segment can rise in the manner of a centre.

The intention of this is to have a piece of money placed on the die within the space, W; then, when the pressure is made upon the piece, the die descends some space, and by this motion the segments close together around the edge-piece, and imprint upon the edge of it. When all the segments come into one plane, the die arrives at the firm seat, and the metal receives the stroke which makes the impressions on its surfaces. The die is suspended in a sort of cup, which rises and falls with the screw, nearly the same as the collar, F, in fig. 13. The money, when struck, is passed through tubes of the diameter of the different species, which readily detects any pieces which may have been improperly struck.

*Mr. Bolton's Cutting-out Press employed at the Royal Mint.*— In the process of coining followed at the Royal Mint, plates of metal are cut out into circular pieces, nearly of the size of the intended coin, by a machine invented by Mr. Matthew Bolton, and for which he obtained a patent in 1790. A drawing of it is exhibited in fig. 12, where C C C is a cast-iron frame, that is fixed on a stone basement. E is a screw, which is fitted through the top of the frame, and actuates a slider F. At the lower end of the slider a steel punch *a* is fixed, the diameter of which is equal to that of the pieces which are to be cut out: *c* is the steel die, which has a hole in it of a proper size to fit the steel punch; *d* is a box, with screws for adjusting the die, so that the hole in it will be exactly beneath the punch. The slider F is fitted into a socket G, which guides it, so that it descends exactly into the hole in the die. *e* is a piece of iron fixed at a small distance above the die *c*, and with a hole through it to admit the punch; the design of this piece is to hold down the piece of metal when the punch rises, otherwise the piece would stick to the punch. On the upper end of the screw a piece Q is fixed, from which an arm projects, with a weight P at the end; it is this weight which gives the necessary momentum to punch out the piece. D is a spindle fixed upon the piece Q, in the line of the screw, and supported in a collar A at the upper end; above this collar a lever D G F is fixed, at one extremity of which there is a roller F, that is acted upon by the projecting teeth of a large horizontal wheel, turned round by the power of a mill. When the wheel turns it catches the roller F, which turns the lever round, and thereby winds up the screw, and raises the punch out of the die. The same action draws a rod H, which is connected with the lever by a joint: the other end of this rod is connected with a bended lever, from the other arm of which a rod descends, and has a piston fixed to it. This piston is fitted into a close cylinder; hence, when the piston is drawn up, it makes a vacuum in the cylinder, and the pressure of the atmosphere on the piston causes a reaction; and the instant that the roller F escapes or slips off from the tooth of the wheel, the reaction of the piston draws the joint H back, and makes the screw turn round in that direction, which causes the punch to descend and cut out a piece from a plate of silver or gold laid upon the die. When the machine requires to be stopped, there is a catch, which is suffered to rise up and hook the lever G. The catch is thrown up by a spring, to which a cord, with a treadle, is fastened. A boy who applies the plates of metal to this machine, places his foot on the treadle, draws down the spring and catch, and then the machine makes a cut every time that a cog of the great wheel passes by; but if the boy relieves the treadle, then the spring lifts up the catch; and when the end of the lever G comes over the catch, it will be caught thereby, and held fast from returning by the action of the exhausted cylinder. R is a strong wooden spring, against which the balance-weight P strikes to stop its motion when it has made its required stroke to pierce the plate. Twelve of these cutting-out presses are to be seen at the Royal Mint, arranged in a circle round a great wheel, which is turned by a steam-engine, and has a large fly-wheel fixed on the same axis, just above the wheel, to regulate the motion. The stone basement on which the presses are fixed is circular, and the bearings A are all fixed in a circular iron frame, erected on an iron column placed between each press. The whole forms a very handsome colonnade, and is placed in the centre of a circular room, which is lighted by a sky-light in the dome. The air cylinders are placed within hollow pilasters, which ornament the walls of the room, and appear to support the dome. The whole presents as elegant an arrangement of machinery as can well be conceived.

Mint. *See* Mentha.

MINUTE, the sixtieth part of a degree; or, in time, the sixtieth part of an hour. These are both denoted by a small dash, as ′ placed over the number of them; though, to prevent confusion, it is better to mark the latter by a small *m*.

MIRA, a singular star in the neck of Cetus, discovered in 1596, and marked in the British catalogue as a star of the third magnitude, appears and disappears periodically seven times in six years, continuing in the greatest lustre for fifteen days together. During 334 days, it continually shines with its greatest light, appearing as a star of the third magnitude; then it diminishes till it entirely disappears for some time from the naked eye. In fact, during that period it passes through its several degrees of magnitude, both increasing and diminishing.

MIRACLE, in its original sense, is a word of the same import with wonder; but in its usual and more appropriate signification, it denotes "an effect contrary to the established constitution and course of things, or a sensible deviation from the known laws of nature." The history of almost every religion abounds with relations of prodigies and wonders, and of the intercourse of men with the gods; but we know of no religious system, those of the Jews and Christians excepted, which appealed to miracles as the sole evidence of its truth and divinity. The pretended miracles mentioned by pagan historians and poets are not said to have been publicly wrought, to enforce the truth of a new religion, contrary to the reigning idolatry. Many of them may be clearly shewn to have been merely natural events. *See* Magic. Others of them are represented as having been performed in secret on the most trivial occasions, and in obscure and fabulous ages, long prior to the era of the writers by whom they are recorded. And such of them as at first view appear to be best attested, are evidently tricks contrived for interested purposes; to flatter power, or to promote the prevailing superstitions. For these reasons, as well as on account of the immoral character of the divinities by whom they are said to have been wrought, they are altogether unworthy of examination, and carry in the very nature of them the completest proofs of falsehood and imposture.

MIRAGE, a name given by the French sailors to an optical phenomenon, on which M. Monge read his memoir to the Institute at Cairo, during the French invasion of Egypt. It often happens at sea, that a ship seen at a distance appears as if painted in the sky, and not to be supported by water. A similar effect was observed by the French in the course of their march through the Desert. The villages seen at a distance, seemed to be built on an island in the middle of a lake. In proportion as they approached, the apparent surface of the water became narrower, and ultimately disappeared entirely; while the same illusion was repeated on a village at a little farther distance. This phenomenon has been variously accounted for by different philosophers. Monge ascribes the effects to a diminution of density in the lower stratum of the atmosphere. This, in the Desert, is produced by the increase of heat, arising from those communicated by the rays of the sun to the sand with which this stratum is in immediate contact. At sea, it takes place where, by particular circumstances, such as the action of the wind, the lower stratum of the atmosphere holds in solution a greater quantity of water than the other strata. In this state of things, the rays of light which come from the lower part of the heavens, having arrived at the surface that separates the less dense stratum from those above it, do not pass through that stratum, but are reflected, and paint in the eye of the observer an image of the heavens; which appearing to him to be below the horizon, he takes it for water when the phenomenon occurs on land. And if at sea, he thinks he sees in the heavens all those objects which float on that part of the surface occupied by the image of the heavens.

MIRROR, in Catoptrics, any polished body impervious to the rays of light, and which reflects them equally. Mirrors were anciently made of metal; but, at present, they are generally smooth plates of glass, tinned or quicksilvered on the back part, and called looking-glasses. Mirrors are either plane, convex, or concave. The first sort reflects the rays of light in the direction exactly similar to that in which they fall upon it, and therefore represents bodies of their natural magnitude. But the convex ones make the rays diverging much more than before reflection, and therefore greatly diminish the images of those objects which they exhibit: while the concave ones, by collecting the rays into a focus, not only magnify the objects they shew, but will also burn very fiercely when exposed to the rays of the sun: and hence they are commonly known by the name of burning mirrors. Some of the more remarkable laws and phenomena of plane mirrors are as follows:—1. A spectator will see his image of the same size, and erect, but reversed as to right and left, and as far beyond the speculum as he is before it. As he moves to or from the speculum, his image will, at the same time, move towards or from the speculum, also on the other side. In like manner, if, while the spectator is at rest, an object be in motion, its image behind the speculum will be seen to move at the same rate. Also when the spectator moves, the images of objects that are at rest will appear to approach or recede from him, after the same manner as when he moves towards real objects. 2. If several mirrors, or several fragments or pieces of mirrors, be all disposed in the same plane, they will only exhibit an object once. 3. If two plane mirrors, or speculums, meet in any angle, the eye, placed within that angle, will see the image of an object placed within the same, as often repeated as there may be perpendiculars drawn determining the places of the images, and terminated without the angles. *See* Optics

MISCHIEF, in Law. Malicious mischief is an injury of such a gross nature to personal property, that although it is not done with a felonious intention, or an intent to steal, the law has inflicted punishment upon it by various statutes. Of these, are statutes against destroying dikes and bridges in the fens of Norfolk, &c.; setting fire to stacks of corn, &c., and imprisoning persons on the borders for the purpose of obtaining ransom; killing cattle, maiming sheep, &c., a trespass punishable with treble damages. Captains and mariners setting fire to ships is felony, and also making a hole in a ship in distress, &c., is felony, and death by statute 12 Anne, s 12,

c. 18. Wilfully and maliciously tearing, cutting, spoiling, or defacing the garments of any person in the streets or highways, or assaulting, with intent to do so, is felony. There are acts which relate to the prevention of setting fire to out-houses with corn, damaging fishponds, trees planted in gardens, cutting down sea-banks, hop-binds, setting fire to mines, preventing persons from buying corn, setting fire to gorse, furze, &c.; wilfully burning engines in mines, fences, enclosures, breaking into houses of the plate glass company, with intent to destroy utensils; breaking into houses to cut or destroy cloth, serge, linen, &c., in the loom, and other similar offences.

MISCHNA, or MISNA, the code or collection of the civil law of the Jews. The Jews pretend, that when God gave the written law to Moses, he gave him also another not written, which was preserved by tradition among the doctors of the synagogue, till rabbi Juda, surnamed the Holy, seeing the danger they were in, through their dispersion, or departing from the tradition of their fathers, reduced them to writing. The Misna is divided into six parts: the first relates to the distinction of seeds in a field, to trees, fruits, tithes, &c. The second regulates the manner of observing festivals; the third treats of women and matrimonial cases; the fourth of losses in trade, &c.; the fifth is on oblations, sacrifices, &c.; and the sixth treats of the several sorts of purification.

MISDEMEANOUR, in Law, signifies a crime. Every crime is a misdemeanour; yet the law has made a distinction between crimes of a higher and a lower nature; the latter being denominated misdemeanours, and the former felonies, &c. For the understanding which distinction, we shall give the following definition from Blackstone's Commentaries, vol. iv. p. 5. "A crime, or misdemeanour, is an act committed or omitted, in violation of a public law, either forbidding or commanding it. This general definition comprehends both crimes and misdemeanours; which, properly speaking, are mere synonymous terms; though, in common usage, the word crime is made to denote such offences as are of a deeper and more atrocious dye; while smaller faults and omissions of less consequence, are comprised under the gentler name of misdemeanours only."

MISE, in Law books, is used in various senses. Thus it sometimes signifies costs or expenses, in which sense it is commonly used in entering of judgments in actions personal. It is also used for the issue to be tried on the grand assize; in which case, joining of the issue upon the mere right, is putting in issue between the tenant and demandant,—who has the best or clearest right.

MISERICORDIA, in Law, is an arbitrary fine imposed on any person for an offence. This is called misericordia, because the amercement ought to be but small, and less than that required by magna charta. If a person be outrageously amerced in a court that is not of record, the writ called *moderata misericordia*, lies for moderating the amercement according to the nature of the fault.

MISFEASANCE, in Law books, signifies a trespass.

MISFORTUNE, an unlucky accident.—Misfortune, or chance, in Law, a deficiency of the will; or committing an unlawful act by misfortune or chance, and not by design. In such case, the will observes a total neutrality, and does not co-operate with the deed; which therefore wants one main ingredient of a crime. *See* CRIME. Of this, when it affects the life of another, we have spoken under the article HOMICIDE; and in this place have only occasion to observe, that if any accidental mischief happen to follow from the performance of a lawful act, the party stands excused from all guilt; but if a man be doing any thing unlawful, and a consequence ensues which he did not foresee or intend, as the death of a man, or the like, his want of foresight shall be no excuse; for, being guilty of one offence, in doing antecedently what is in itself unlawful, he is criminally guilty of whatever consequence may follow the first misbehaviour.

MISNOMER, in Law, a misnaming or mistaking a person's name. The Christian name of a person should always be perfect; but the law is not so strict in regard to surnames, a small mistake in which will be dispensed with, to make good a contract, and support the act of the party. *See* PLEA TO INDICTMENT.

MISPRISION, a neglect, oversight, or contempt, applied chiefly to misprision of treason, which is a negligence in not revealing treason, or felony, to a magistrate, where a person knows it to be committed: it is also applied to great misdemeanours. It is, therefore, negative or positive, as it is an act or a concealment of crime. To avoid misprision of treason, the party must make full discovery to a magistrate. To counterfeit foreign coin, not current here, is misprision of treason. A misprision of felony may be by concealing it, or by taking back again a man's goods which have been stolen, which is now made felony. Concealing treasure trove falls under this head. In the class of positive misprisions, or high misdemeanours, are the mal-administration of high officers, and embezzling public money. Contempts against the king's authority, some of which incur a præmunire; contempts against the king's palace or courts. In the palace, if blood be drawn in a malicious assault, it is punishable by perpetual imprisonment, fine, and loss of the offender's right hand, 33 Henry VIII. c. 12. And striking, whether blood is drawn or not, in the king's superior courts, or at the assizes, is punishable with equal or greater severity. A rescue of a prisoner in such a court is punished with perpetual imprisonment, and forfeiture of goods, and the profit of lands during life. Of a less degree are reckoned also the injurious treatment of those who are under the immediate protection of a court of justice, the dissuading a witness from giving evidence, and the disclosing, by a grand jury, to the person indicted, of the evidence against him.

MISRECITAL, in deeds, is sometimes injurious, and sometimes not; if a thing be referred to time, place, and number, and that is mistaken, all is void.

MISSIONARIES, such ecclesiastics as are sent by any Christian church into pagan or infidel countries, to convert the natives, and establish the Christian religion among them. Custom, the tyrant of language, has applied this term in a sense very different from its original acceptation; for there may be missions political or commercial, as well as religious.

MISSIVE, something sent to another, as missive letters; meaning letters sent from one to another upon business, in contradistinction to letters of gallantry, points of learning, despatches, &c.

MITE, a small coin, formerly current, equal to about one-third of a farthing. It also denotes a small weight used by the moneyers. It is equal to the twentieth part of a grain, and divided into twenty-four doits.

MITRE, a sacerdotal ornament worn on the head by bishops, and certain abbots, on solemn occasions; being a sort of cap, pointed, and cleft at top. The high priest among the Jews wore a mitre or bonnet on his head. The inferior priests among the Jews had likewise their mitres. Those young women among the primitive Christians who professed a state of virginity, and were solemnly consecrated thereto, wore a purple and golden mitre as a badge of distinction. The pope has no less than four different mitres, which are more or less rich, according to the solemnities of the festivals on which they are worn. The cardinals anciently wore mitres; some canons of cathedrals have the privilege of wearing the mitre; and some great families in Germany bear it for their crest.

MITTIMUS, a writ by which records are transferred from one court to another. The precept directed to a gaolor, under the hand and seal of a justice of the peace, for the receiving and safe keeping a felon, or other offender, by him committed to gaol, is called a mittimus.

MIZZEN, the aftermost or hindermost of the fixed sails of a ship, extended sometimes by a gaff, and sometimes by a yard which crosses the mast obliquely, the fore end reaching almost down to the deck, and the after end being peeked up as high above the middle of the yard which is attached to the mast; the head and foreleech, or the mizzen, are laced upon the gaff (or yard) and mast, and the sheet hauls out near the tafferel.

MIZZEN *Mast*, the mast which supports all the after sails The explanations of the rigging, yards, and sails of this mast being in general applicable also to the same furniture of both the other masts, the reader is referred to the articles SHROUD, STAY, YARD, &c. observing only that the epithet of Fore, Main, or Mizzen, is added to each term, to distinguish them from each other.

**MNEMONICS**, the art of improving the memory. It sufficiently appears that the principal expedient for assisting this useful faculty is derived from association, and of this Simonides and Cicero availed themselves in the early ages. All the abilities of the mind borrow from memory their beauty and perfection; without this, the other faculties of the soul are almost useless. To what purpose are all our labours in knowledge and wisdom, if we want memory to preserve and use what we have acquired? What avail all our intellectual or spiritual improvements, if they are lost as soon as they are obtained! Memory alone enriches the mind, by preserving what our labour and industry have collected. Without memory, there can be neither knowledge, nor arts, nor sciences. Without the assistance and influence of this power, mankind would experience no improvement in virtue, in morals, or in religion. The soul of man would be but a poor, destitute, naked being, without memory. If we except the fleeting ideas of the moment, it would present an everlasting blank.

It is often found, that a fine genius has but a feeble memory; for where the genius is bright, and the imagination vivid, the power of memory may be too much neglected, and lose its improvement. An active fancy readily wanders over a multitude of objects, and is continually entertaining it with new and transitory images. It runs through a number of new scenes, or new pages, with pleasure, but without due attention; and seldom suffers itself to dwell upon any of them long enough for the mind to receive a deep impression, or for the remembrance of the subject to be lasting.* Consequently, many persons of very bright parts, and active spirits, have but short and narrow powers of recollection; possessing riches of their own, they are not solicitous to borrow from the stores of others. When the memory has been almost constantly employed in making new acquirements, and when there has not been a judgment sufficient to distinguish what was fit to be remembered, and what was idle, trifling, or needless, the mind has been filled with a wretched heap of words or ideas. In this case, the soul had large possessions, but no true riches. "Whatever," as Milton says, "old *Time*, with his *huge drag net*, has conveyed down to us, along the stream of ages; whether it be *shells* or *shell fish*, *jewels* or *pebbles*, *sticks* or *straws*, *sea weeds* or *mud*;" all is treasured up indiscriminately, by those persons who have not the judgment to determine what is to be remembered, and what is to be forgotten. How many excellent judgments and reasonings are framed in the mind of a wise and studious man, in a length of years! How many worthy and admirable notions has he possessed in life, both by his own reasonings, and by his prudent recollections in the course of his reading! But, alas! how many thousands of them vanish, and are lost for want of a happy and retentive memory.

Mr. Locke, speaking of the continual decay of our ideas, beautifully observes, "The ideas, as well as children of our youth, often die before us: and our minds represent those tombs to which we are approaching; where, though the brass and marble remain, yet the inscriptions are effaced by time, and the imagery moulders away. The pictures drawn in our minds are laid in fading colours, and, if not sometimes refreshed, vanish and disappear. How much the constitution of our bodies, and the make of our animal spirits, are concerned in this, and whether the temper of the brain makes this difference, that, in some it retains the characters drawn on it like marble, in others like free stone, and in others little better than sand; I shall not here inquire: though it may seem probable, that the constitution of the body does sometimes influence the memory; since we oftentimes find a disease quite strip the mind of all its ideas, and the flames of a fever, in a few days, calcine all those images to dust and confusion, which seemed to be as lasting as if graved in marble."

A good memory has these qualifications: (1.) It is ready to receive and admit, with perfect ease, the various ideas of words and things which are learned or taught. 2. It is copious enough to treasure up these ideas in great number and variety. 3. It is sufficiently strong, to retain, for a considerable time, those words or thoughts which are committed to its care. 4. It possesses the power of suggesting and recollecting, from the abundance of its store, words or thoughts proper for every occasion in life.

*Rules for Improving the Memory.*—Many rules have been given for the regulation of this important faculty: the following, if attentively practised, will conduce much to the solid and lasting improvement of the memory.

*Temperance in eating, drinking, and sleep.*—The memory depends much upon the state of the brain, and therefore what is hurtful to the latter must be prejudicial to the former. Too much sleep clouds the brain, and too little overheats it; therefore, either of these extremes ought to be avoided. Intemperance of all kinds, and excess of passion, have the same ill effects.

*A clear and distinct apprehension of what we wish to remember.* We should understand the subject thoroughly, and fix our view particularly upon its importance.

*An abridgment of a good book is, sometimes, a very useful exercise.*—In general we should preserve the doctrines, sentiments, or facts, that occur in reading; we should lay the book aside, and put them in our own words.

*Method and regularity are essentially necessary.*—Those things are best remembered, the parts of which are methodically disposed and mutually connected.

*Repetition and review.*—When a person is hearing a sermon, or a lecture, he should endeavour to recollect the several heads of it, from the beginning, two or three times before the discourse is finished. The omission or the loss of a few sentences is amply compensated by preserving in the mind the method and order of the whole discourse, in all its most important branches. Discoursing with our companions on what we have been reading, or teaching it to our younger friends, is an excellent mode of repetition, and contributes, more than any other perhaps, to assist the memory. The memory gains great advantage by having the objects of our learning drawn out into schemes or tables. The situation of the several parts of the earth is better learned by one day's consultation with the terrestrial globe, than by merely reading the description of their situation a hundred times over in books of geography. Writing what we wish to remember once, and giving it due attention, will fix it more in the mind than reading it several times. What we have *seen* is not so soon forgotten as what we have only *heard*. What Horace affirms of the mind or passions, is not less applicable to the memory:

> Sounds which address the ear are lost and die
> In one short hour; but that which strikes the eye
> Lives long upon the mind; the faithful sight
> Engraves the knowledge with a beam of light.

*Rhyme.* The memory of useful things may receive considerable aid, if they are thrown into verse. For the numbers and measures, and rhyme, according to the poesy of different languages, assist us very materially in receiving what is proposed to our observation, and in preserving it long in our remembrance. How many of the common affairs of human life taught in early years are indelibly fixed in our memories by the aid of rhyme.

*Initial Letters.*—It has sometimes been the practice to imprint names or sentences on the memory, by taking the first letter of every word of that sentence, or of those names, and making a new word out of them. The name of the *Maccabees* is borrowed from the first letter of the Hebrew words which make the sentence, *Mi Camoka, Baelim Jehovah*, that is, Who is like thee among the gods?—which was written on their banners. So the word *Vibgyor* teaches us to remember the order of the seven original colours as they appear by the sun-beams, cast through a prism on white paper, or formed by the sun in a rainbow, according to the different refrangibility of the rays, *viz.* violet, indigo, blue, green, yellow, orange, and red.

*Common Place Book.*—There have been many different modes of keeping this book offered to our attention, and almost every person has one peculiar to himself. That which Mr. Locke found, after twenty years' experience, to be the most convenient and advantageous, is thus described. The first page of the book, or, for more room, the two first pages fronting each other, are to serve for a kind of index to the whole, and contain references to every place or matter therein; in the commodious contrivance of this, so as it may admit of a sufficient variety of materials, without confusion, all the secret of the method consists. The manner of it, as laid down by Mr. Locke, will be conceived from the following specimen, wherein what is to be done in the book for all the letters of the alphabet, is here shewn in the first four.

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* In all these cases, (says Locke,) ideas in the mind quickly fade, and often vanish quite out of the understanding, leaving no more footsteps or remaining characters of themselves, than shadows do flying over fields of corn; and the mind is as void of them as if they had never been there.

| | | |
|---|---|---|
| A | *a* | |
| | *e* | |
| | *i* | |
| | *o* | |
| | *u* | |
| B | *a* | |
| | *e* | 2. 3. |
| | *i* | |
| | *o* | |
| | *u* | |
| C | *a* | |
| | *e* | |
| | *i* | |
| | *o* | |
| | *u* | |
| D | *a* | |
| | *e* | |
| | *i* | |
| | *o* | |
| | *u* | |

The index of the common place book being thus formed, it is ready for the taking down any thing therein. In order to this, consider to what head the thing you would enter is most naturally referred, and under which one would be led to look for such a thing; in this head or word regard is to be had to the initial letter, and the first vowel that follows it; which are the characteristic letters whereon all the use of the index depends. Suppose I would enter down a passage that refers to the head beauty; B, I consider, is the initial letter, and *e* the first vowel, then looking upon the index of the partition B, and therein the line *e* (which is the place for all words whose initial is B, and the first vowel *e*; as beauty, beneficence, bread, bleeding, blemishes, &c.) and finding no numbers already written to direct me to any page of the book where words of that characteristic have been entered, I turn forward to the first blank page I find, which in a fresh book, as this is supposed to be, will be page 2, and here write what I have occasion for on the head beauty; beginning the head in the margin, and indenting all the other subservient lines, that the head may stand out and shew itself; this done, I enter the page where it is written, *viz.* 2, in the space B *e*; from which time the class B *e*, becomes wholly in possession of the second and third pages, which are consigned to letters of this characteristic.

*Note.* If the head be a monosyllable beginning with a vowel, the vowel is at the same time both the initial letter and the characteristic vowel; thus the word *Art* is to be written in A *a*. Mr. Locke omits three letters of the alphabet in his index, *viz.* K, Y, and W, which are supplied by C, I, and U, equivalent to them; and as for Q, since it is always followed by an *u*, he puts it in the first place of Z; and so has no Z *u*, which is a characteristic that very rarely occurs. By thus making Q the last of the index, its regularity is preserved without diminishing its extent. Others choose to retain the class Z *u*, and assign a place for Q *u* below the index.

If any imagine these hundred classes are not sufficient to comprehend all kinds of subjects without confusion, he may follow the same method, and yet augment the number to 500, by taking in one or more characteristic to them. But the inventor assures us, that in all his collections for a long series of years, he never found any deficiency in the index as above laid down.

The most effectual method of improving the memory is by due and proper exercise. Our memories will be in a great measure molded and formed, improved or injured, according to the exercise of them. If we *never* use them, they will be almost lost. Those who are accustomed to converse and read of a few things only, will retain but a few in their memory. Those who are used to remember an event for an hour, and to charge their memories with it no longer, will retain this event but an hour before it vanishes. But, on the other hand, especial care should be taken, that the memory of the learner be not crowded with too great a variety of ideas at one time. This is the way to learn nothing; one idea effaces another.

*The Memory can be improved only by moderate exercise.*—Such is the opinion of Dr Watts, a high authority in matters of this nature, respecting the improvements of the natural memory. The recollection which ordinary memories possess, appears to be resolvable into two principal sources, the *vivacity* of the impression, and *association*. Singularity of impression is generally accompanied with vivacity, but association is the principal expedient for assisting the memory. Thus "when I see the house of my friend, I recollect his family; when I hear of Waterloo, I recollect the overthrow of Napoleon."

MOAT, or DITCH, in Fortification, a deep trench dug round the rampart of a fortified place, to prevent surprises. The brink of the moat next the rampart, is called the scarp; and the opposite one, the counterscarp. A dry moat round a large place, with a strong garrison, is preferable to one full of water; because the passage may be disputed inch by inch, and the besiegers, when lodged in it, are continually exposed to the bombs, grenades, and other fire-works, which are thrown incessantly from the rampart into their works. In the middle of dry moats, there is sometimes another small one called lunette, which is generally dug so deep till they find water to fill it. The deepest and broadest moats are accounted the best, but a deep one is preferable to a broad one; the ordinary breadth is about twenty fathoms, and the depth about sixteen. To drain a mote that is full of water, they dig a trench deeper than the level of the water, to let it run off, and then throw hurdles upon the mud and slime, covering them with earth or bundles of rushes, to make a sure and firm passage.

MOBILITY, a contingent property of bodies, but most essential to their constitution. Every body at rest can be put in motion, and if no impediment intervenes, this change may be effected by the slightest external impression. Thus, the largest cannon ball, suspended freely by a rod or chain from a lofty ceiling, is visibly agitated by the horizontal stroke of a swan shot, which has gained some velocity in its descent through the arc of a pendulum. In like manner, a ship of any burden is, in calm weather and smooth water, gradually pulled along even by the exertions of a boy. A certain measure of force, indeed, is often required to commence or to maintain the motion; but this consideration is wholly extrinsic, and depends on the obstacles at first to be overcome, and on the resistance which is afterwards encountered. If the adhesion and intervention of other bodies were absolutely precluded, motion would be generated by the smallest pressure, and would continue with undiminished energy.

MODE, in Logic, called also syllogistic mood, a proper disposition of the several propositions of a syllogism, in respect of quantity and quality.

MODE, in Philosophy, denotes the manner of a thing's existence.

MODEL, in a general sense, an original pattern, proposed for any one to copy or imitate. This word is particularly in building, as applicable to an artificial pattern made in wood, stone, plaster, or other matter, with all its parts and proportions, in order for the better conducting and executing some great work, and to give an idea of the effect it will have when finished. They also use models in painting and sculpture; whence in the academies of painting they give the term Model to a naked man or woman, disposed in several postures, to afford an opportunity to the scholars to design him in various views and attitudes. Models in imitation of any natural or artificial substance, are most usually made by means of moulds composed of plaster of Paris. Thus, when a model is to be taken, the surface of the original is first greased, to prevent the plaster from sticking to it. The original is then laid on a smooth table, previously greased, or covered with a cloth to prevent the plaster sticking to it: then surround the original with a frame or ridge of glaziers' putty, at such a distance from it as will admit the plaster to rest upon the table, on all sides of the subject, for about an inch, or as much as is sufficient to give the proper degree of strength to the mould. A sufficient quantity of plaster is then to be poured as uniformly as possible over the whole substance, until it is every where covered to such a thickness as to give a proper substance to the mould, which may vary in proportion to the size. The whole must then remain in this condition till the plaster has attained its hardness: when the frame is taken away, the mould may be inverted, and the subject removed from it; and when the plaster is thoroughly dry, let it be well seasoned.

MODULATION, in Music, the art of conducting harmony, in composition, or extemporary performance, through those keys and modes which have a due relation to the fundamental or original key.

MODUS DECIMANDI, in Law, is where money, land, or other valuable consideration, has been given, time out of mind, to the minister or parson of any certain place, in the room of tithes.

MOHAIR, the hair of a kind of goat, frequent about Angora, in Turkey.

MOISTURE, a term sometimes used to denote animal fluids, the juices of plants, or dampness of the air or other bodies.

MOLE, a name given in the Mediterranean to a long pier or artificial bulwark of masonry, extending obliquely across the entrance of a harbour, in order to break the force of the sea from the vessels that are anchored within.

Mole, is also applied to the harbour or haven which is formed by the bulwark above described, which latter is then denominated the mole head.

MOLECULÆ, the same as Atoms.

MOLLUSCA, in Natural History, the second order of the Linnæan class vermes. They are naked; furnished with tentacula, or arms; for the most part inhabitants of the sea; and, by their phosphoreous quality, illuminate the dark abyss of the waters. This order is composed of simple animals furnished with limbs.

MOLOSSES, the thick fluid matter remaining after the sugar is made, resembling syrup.

MOLYBDATES, in Chemistry, salts formed from the molybdic acid, and the earths, alkalies, &c. They are colourless, and soluble in water; they have a metallic taste. The prussiate of potash throws down from several of them a light brown-coloured precipitate.

MOLYBDENA, or Sulphuret of Molybdenum, occurs massive, disseminated, and rarely crystallized. Its colour is like that of fresh cut metallic lead. It occurs in granular distinct concretions; it is opaque, stains the fingers, and leaves shining traces when drawn over paper; it is very soft, and easily divisible in the direction of the laminæ. Specific gravity 4·5 to 4·7. It is infusible before the blow-pipe, but exhales a sulphureous odour; at a very high heat it melts, gives out white fumes, and burns with a blue flame. It is found in Norway, Sweden, Saxony, and in Mont-Blanc in Switzerland.

MOLYBDENUM, a metal of a grayish-white colour, in the form of brittle infusible grains. In the analysis was obtained sulphur, and a whitish powder, which is a metallic oxide, and possesses the properties of an acid. Hitherto this metal is only obtained in grains, the greatest heat has not been sufficient to melt it into a button; its specific gravity is 7·4.

MOLYBDIC or Molybdous *Acid.* (See above.) Molybdic acid combines with alkalies, earths, and several metallic oxides, and forms molybdates, which see. This acid, combined with potash, forms a colourless salt; mixed with filings of tin and muriatic acid, it becomes blue, and precipitates flakes of the same colour, which disappear after some time; 100 parts are composed of 67 molybdenum, and 33 oxygen.

MOLYNEAUX, William, a celebrated astronomer and mathematician, was born at Dublin, in the year 1656, and died in 1698.

Molyneaux, *Samuel*, son of the former, was also an able astronomer; but his public situation prevented him from pursuing the subject to the same extent as had been done by his father.

MOMENT, an indefinite small portion of time, having the same relation to duration as a point has to a line.

Moment, in the Modern Analysis, is the same as *Infinitesimal*, *Increment*, or *Decrement*; for an explanation of which see those terms.

MOMENTUM, in Mechanics, is the same with impetus, or quantity of motion, and is generally estimated by the product of the velocity and mass of the body. This is a subject, however, which has led to various controversies between philosophers, some estimating it by the mass into the velocity, as stated above, while others maintain, that it varies as the mass into the square of the velocity. But this difference seems to have arisen rather from a misconception of the term, than from any other cause: those who maintain the former doctrine, understanding momentum to signify the momentary impact; and the latter, as the sum of all the impulses till the motion of the body is destroyed. *See* Force.

MOMORDICA ELATERIUM. *Spirting Cucumber.*—The fruit of the Elaterium is a strong cathartic, and very often operates also upwards. Two or three grains are accounted in most cases a sufficient dose. Simon Paulli relates some instances of the good effects of this purgative in dropsies: but cautions practitioners not to have recourse to it till after milder medicines have proved ineffectual; to which caution we heartily subscribe. Medicines indeed, in general, which act with violence in a small dose, require the utmost skill to manage them with any tolerable degree of safety: to which may be added, that the various methods of making these kinds of preparations, as practised by different hands, must needs vary their power.

MONADES. *See* Digits.

MONARCHY, a government in which the supreme power is invested in a single person. There are several kinds of monarchies, as, where the monarch is invested with an absolute power, and is accountable to none but God; or limited, where the supreme power is virtually in the laws, though the majesty of government and the administration is vested in a single person. Monarchies are also either hereditary or elective, where the choice depends upon all who enjoy the benefit of freedom, or upon a few persons in whom the constitution vests the power of election.

MONASTERY, a convent, or house built for the reception and entertainment of monks, medicant friars, or nuns, whether it be an abbey, priory, &c.

MONEY, the medium of commerce, commonly metal, and generally of a determined shape and weight to which public authority has affixed a certain value. Money is usually divided into real or effective; and imaginary, or money of account. Real money includes all coins or species of gold, silver, copper, &c. which exist and have currency. Imaginary money, or money of account, is that which has never existed, or at least which does not exist in real specie, but is a denomination invented or retained to facilitate the stating of accounts, by keeping them still on a fixed footing, not to be changed like current coins. No person is obliged to take in payment any money which is not lawful metal, that is, of silver and gold, except for sums under sixpence. But it was decided in Hilary term, 1790, that bank notes were considered as money, and therefore a proper tender in payment.

*English Money of Account*, is the pound, shillings, and pence, the pound contains twenty shillings, and the shilling twelve pence. Originally the pound was one pound weight of silver, which was coined into twenty shillings, and a penny was a pennyweight, or the 240th part of a pound. In Scotland, the denominations were the same, but the pound of silver was gradually coined into more and more shillings, until at last the pound was reduced to only one-twelfth part of the value of the present pound sterling.

*French Money of Account* is francs and centimes: sous still appear sometimes in accounts, and 20 of them make a franc.

Money *bringing into Court.* In some actions of law the defendant is allowed to pay a sum into court, which he contends is the fair amount of the plaintiff's just demand, and the plaintiff will afterwards proceed at his peril.

MONOCEROS, *the Unicorn*, is a modern constellation formed by that great innovator Hevelius, out of the stellæ informes of the ancients.—*Boundaries and Contents:* N. by Gemini, Canis Minor, and Hydra; E. by Hydra; S. by Argo Navis and Canis Major; and W. by Orion. There are thirty-one stars assigned to this constellation in the Britannic Catalogue, *viz.* ten of the fourth magnitude, and the remainder of smaller magnitudes.

MONOCHORD, in Music, an instrument so called because it is furnished with only one string. Its use is to measure and adjust the ratios of the intervals, which it effects by the means of moveable bridges calculated to divide the chord at the pleasure of the performer.

MONOCULUS, in Natural History, a genus of insects of the order aptera. There are about 50 species, separated into sections.

MONODON, the *Narwhal*, in Natural History, a genus of mammalia, of the order cetæ. The only genus of this species is M. monoceros, or the unicorn narwhal, found in the northern seas, and generally of the length of twenty feet from the mouth to the tail; from a socket in the upper jaw on one side, a tooth somewhat resembling a horn grows in a perfectly straight direction, and a wreathed or screw-like form, to the length of six, and occasionally nine or ten feet, of a light yellow colour, and terminating in a sharp point, a circumstance by which it is discriminated from every other species of whales. The incipient protrusion of a second tooth on the other side of the jaw is generally perceivable, and in some instances, though rarely, both advance to maturity. The narwhals subsist principally upon flat-fish. They are seldom observed in the open sea, and frequent the unfrozen spots near the coasts of the arctic regions. They are taken by the Greenlanders in great abundance by the harpoon; their flesh is eaten prepared in various ways, and the oil and intestines are also articles in great request. The tendons are split into thin fibres, serving the purposes of thread, and the teeth are used sometimes for hunting horns, and more frequently as pillars and gate posts in houses. These horns were formerly considered as indicative of royal state and magnificence, being employed as the ornaments of palaces.

MONOGRAM, a character or cipher, composed of one, two, or more letters interwoven; being a kind of abbreviation of a name, anciently used as a seal, badge, arms, &c. The use of arms is very ancient, as appears from Plutarch, and from some Greek medals of the time of Philip of Macedon and Alexander his son. The Roman labarum bore the monogram of Jesus Christ, which consisted of two letters, a P placed perpendicularly through the middle of an X, as we find it on many medals in the time of Constantine, these being the two first letters of the word ΧΡΙΣΤΟΣ. Thus, under the Eastern empire, it is usual to find MIK, which are the monogram of Mary, Jesus, Constantine.

MONOMIAL, in Algebra, is a quantity consisting only of one term; as $a\,x$, $3\,b\,x^2$, &c.

MONOTONY, an uniformity of sound, or fault in pronunciation, when a long series of words are delivered in one unvaried tone.

MONS MENSÆ, *the Table Mountain*, a modern asterism, situated between the Southern Pole of the World and the Ecliptic, contains thirty stars: this constellation culminates with Auriga and Orion.

MONSOON, a species of trade wind in the East Indies, which for six months blows constantly the same way, and the contrary way the other six months. However, it ought to be observed, that the points of the compass from whence the monsoons blow, as well as the times of their shifting, differ in different parts of the Indian ocean. The cause of monsoons is this: when the sun approaches the northern tropic, there are countries, as Arabia, Persia, India, &c. which become hotter, and reflect more heat than the seas beyond the equator, which the sun has left; the winds, therefore, instead of blowing from thence to the parts under the equator, blow the contrary way; and when the sun leaves those countries, and draws near the other tropic, the winds turn about, and blow on the opposite point of the compass.

MONTGOLFIER, a name sometimes given to those balloons which receive their buoyancy from the burning of combustible materials; being thus denominated after the name of their inventor, by which name they are also distinguished from the inflammable air-balloons. *See* Aerostation.

MONTH, the twelfth part of the year, and is so called from the moon, by whose motions it was regulated, being properly the time in which the moon runs through the zodiac. The lunar month is either *illuminative*, *periodical*, or *synodical*.

*Illuminative* Month, is the interval between the first appearance of one new moon and that of the next following. As the moon appears sometimes sooner after one change than after another, the quantity of the illuminative month is not always the same. The Turks and Arabs reckon by this month.

*Lunar Periodical* Month, is the time in which the moon runs through the zodiac, or returns to the same point again; the quantity of which is $27^d\ 7^h\ 43^m\ 8^s$.

*Lunar Synodical* Month, called also a lunation, is the time between two conjunctions of the moon with the sun, or between two new moons; the quantity of which is $29^d\ 12^h\ 44^m\ 3^s\ 11'''$. The ancient Romans used lunar months, and made them alternately of twenty-nine and thirty days. They marked the days of each month by three terms, *viz. Calends*, *Nones*, and *Ides*.

*Solar* Month, is the time in which the sun runs through one entire sign of the ecliptic; the mean quantity of which is $30^d\ 10^h\ 29^m\ 5^s$, being the twelfth part of $365^d\ 5^h\ 49^m$, the mean solar year.

*Astronomical* or *Natural* Month, is that measured by some exact interval corresponding to the motion of the sun or moon; such are the lunar and solar months above mentioned.

*Civil* or *Common* Month, is an interval of a certain number of whole days, approaching nearly to the quantity of some astronomical month. These may be either lunar or solar.

The *Civil Lunar* Month consists alternately of twenty-nine and thirty days. Thus will two civil months be equal to two astronomical ones, abating for the odd minutes; and so the new moon will be kept to the first day of such civil months for a long time together. This was the month in civil or common use among the Jews, Greeks, and Romans, till the time of Julius Cæsar.

The *Civil Solar* Month, consisted alternately of thirty and thirty-one days, excepting one month of the twelve, which consisted only of twenty-nine days; but every fourth year of thirty days. The form of civil months was introduced by Julius Cæsar. Under Augustus, the sixth month, till then from its place called Sextilis, received the name Augustus, now August, in honour of that prince; and to make the compliment still greater, a day was added to it, which made it consist of thirty-one days, though till then it had only contained thirty days; to compensate for which, a day was taken from February, making it consist of twenty-eight days, and twenty-nine every fourth year. Such are the civil or calendar months now used through Europe.

MONTH, in Law, is generally a lunar month of twenty-eight days, unless otherwise expressed.

MONTUCLA, John Etienne, a celebrated French mathematician, was born at Lyons, September 5, 1725; and very early in the College of the Jesuits acquired a very intimate knowledge of the Latin and Greek languages, to which he added also several modern languages, as the Italian, English, German, and Dutch; which, joined to a very complete knowledge of the mathematical and philosophical sciences, and a remarkable accuracy of research, eminently qualified him for the performance of that work by which he is most distinguished, and by which he has laid a lasting obligation on every admirer of these sciences, *viz.* his "Histoire des Mathematiques," which first appeared in 1758, in 2 vols. 4to. and which has been since, *viz.* in 1802, republished, and augmented to 4 vols. 4to. by Lalande; the additions being principally drawn from the numerous manuscript notes left by Montucla at the time of his death, which happened at Paris, December 18, 1799.

MONUMENT, in Architecture, a building destined to preserve the memory, &c. of a person who raised it, or for whom it was raised; as, a triumphal arch, a mausoleum, a pyramid, &c.

**MOOD**, or **Mode**, in Grammar, the different manner of conjugating verbs, serving to denote the different affections of the mind.

**MOON**, *Luna*, in Astronomy, one of the heavenly bodies, the constant attendant of our earth, about which she revolves as a centre, illuminating us by her reflected rays in the absence of the sun. The principal elements and phenomena of this body are thus stated by Mr. Baily, in the Philosophical Magazine for January, 1812, in a very neat and useful synopsis of astronomy, drawn principally from the Systeme Du Monde of Laplace. The motions of the moon are exceedingly eccentric and irregular. She performs her mean *sidereal revolution* in $27^{d}\,7^{h}\,43^{m}\,11''\cdot5$; but this period is variable, and a comparison of the modern observations with the ancient proves incontestably an *acceleration* in her mean motion. Her mean *tropical* revolution is $27^{d}\,7^{h}\,43^{m}\,4''\cdot7$, and her mean *synodical* revolution $29^{d}\,12^{h}\,44^{m}\,2''\cdot8$. Her *mean distance* from the earth is 29·982175 times the diameter of the terrestrial equator, or about 237,000 miles. The *eccentricity* of her orbit is ·0548553; the mean distance from the earth being taken equal to unity; but this eccentricity is variable in each revolution. Her *mean longitude*, at the commencement of the present century, was in $3^{s}\,21^{\circ}\,36'\,42''\cdot1$. Her *velocity* varies in different parts of her orbit; she is swiftest in her perigee (or point nearest the earth,) and slowest when in her apogee (or point farthest from the earth); her mean diurnal velocity is equal to $13^{\circ}\,10'\,34''\cdot9$, or about thirteen times greater than that of the sun. The greatest *equation* of her *centre* is $6^{\circ}\,17'\,54''\cdot5$. The mean longitude of her *perihelion* was, at the commencement of the present century, in $8^{s}\,26^{\circ}\,6'\,5''\cdot1$; but the line of the apsides has a motion, according to the order of the signs. The period of a sidereal revolution of the apsides, is $3232^{d}\,13^{h}\,56'\,16''\cdot8$, or nearly nine years. The period of a tropical revolution of the apsides, is but $3231^{d}\,11^{h}\,24'\,8''\cdot6$. But these periods are not uniform, for they have a secular irregularity, and are retarded whilst the motion of the moon itself is accelerated. The period of an *anomalistic* revolution of the moon is $27^{d}\,13^{h}\,18'\,37''\cdot4$. Her orbit is *inclined* to the plane of the ecliptic in an angle of $5^{\circ}\,9'$; but this inclination is variable. The greatest inequality, which sometimes extends to $8'\,47''\cdot51$, is proportional to the cosine of the angle on which the inequality in the motion of the nodes depends. Her orbit, at the commencement of the present century, crossed the ecliptic in $0^{s}\,15^{\circ}\,55'\,26''\cdot3$; but the place of her nodes is variable; these having a retrograde motion, and make a sidereal revolution in $6793^{d}\,10^{h}\,6'\,30''\cdot0$, or in about 18·6 Julian years. This variation, however, is subject to many inequalities; of which, the greatest is proportional to the sine of double the distance of the moon from the sun, and extends to $1^{\circ}\,37'\,45''\cdot0$ at its maximum. A synodical revolution of the nodes is performed in $346^{d}\,14^{h}\,52'\,43''\cdot6$; but the motion of the nodes is subject also to a secular inequality, dependent on the acceleration of the moon's mean motion.

The *rotation* of the moon on her axis is equal and uniform, and is performed in the same time as the tropical revolution in her orbit; whence she always presents nearly the same face to the earth. But as the motion of the moon in her orbit is periodically variable, we sometimes see more of her eastern edge, and sometimes more of her western edge; which appearance is called the *libration* of the moon in *longitude*. The *axis* of the moon is inclined to the plane of the ecliptic in an angle of $88^{\circ}\,29'\,49''$; in consequence of which position of the moon, her poles alternately become visible to and obscured from us; and this phenomenon is called her *libration* in *latitude*. There is also another optical deception, arising from the moon being seen from the surface of the earth, instead of the centre, which is called her *diurnal libration*.

Excellent drawings of the moon have been made by Tobias, Mayer, and Russel; but the most accurate and complete are those of Schroeter, who has given highly magnificent views of several parts of the moon's surface. The most favourable time for viewing the lunar disc, is when she is about five days old; the irregularities in her surface being then the most conspicuous.

It is impossible to say what those unenlightened portions, observable in the disc, are, or what they may have been, but we cannot help thinking that our earth would assume nearly the same appearance, if all the lakes and seas were removed; and who can say but that this may have been the case in the lunar regions? Astronomers formerly supposed, that the dark part of the moon's surface were large lakes and seas, but it is obvious, on an attentive observation with a good telescope, that there are ridges and unevennesses in those parts, which plainly indicate that they are not fluid but solid, like the other parts of her surface; there is, therefore, very little of any fluid matter in this luminary, and hence probably is the reason that her atmosphere is so different from our own; if, indeed, this can be justly inferred from the circumstances usually adduced as arguments in favour of this hypothesis, which appears very doubtful. We have observed, that mountains may always be seen on the surface of the lunar disc; and even volcanoes have been frequently observed, from which some philosophers have supposed the aërolиths, that at times fall to the earth, to have been projected; which it appears, from computation, would only require a velocity of about 8200 feet per second, to cause them to pass from this body to the earth. *See* Astronomy.

*Acceleration* of the Moon. *See* Acceleration.

*Age* of the Moon, is the number of days since the new moon, which is found by the following rule:—To the epact add the number and day of the month, which will be the age required, if less than thirty; and if it exceed thirty, subtract this number from it, and the remainder will be the age. *See* Epact.

*Harvest* Moon, is a remarkable phenomenon relating to the rising of this luminary in the harvest season. During the time she is at the full, and for a few days before and after, in all about a week, there is less difference in the time of her rising between any two successive nights at this than at any other time of the year. By this means she affords an immediate supply of light after sun-set, which is very beneficial in gathering in the fruits of the earth; and hence it is, that this lunation has been termed the harvest moon. In order to conceive this phenomenon, it may first be considered, that the moon is always opposite to the sun when she is full; that she is full in the signs Pisces and Aries in our harvest months, these being the signs opposite to Virgo and Libra, the signs occupied by the sun about the same season; and because those parts of the ecliptic rise in a shorter space of time than others, as may easily be shewn and illustrated by the celestial globe, consequently when the moon is about her full in harvest, she rises with less difference of time, or more immediately after sun-set, than when she is full at other seasons of the year.

Moon *Dial*, is a dial which shews the hours of the night by the light of the moon.

**MOOR**, To, to confine or secure a ship in a particular station by chains or cables, which are either fastened to the adjacent shore, or to anchors in the bottom; a ship is never said to be moored when she rides by a single anchor.

*To* Moor *Across*, is to lay out one of the anchors on one side, or athwart a river, and another on the other side right against it. *To Moor Along*, is to have an anchor in the river, and a hawser on shore. *To Moor a Cable each way*, is performed by dropping one anchor, veering out two cables' lengths, and letting go another anchor from the opposite bow; the first is then hove in to one cable, while the latter is veered out as much, whereby the ship rides between the two anchors, equally distant from both. This is usually practised in a tide-way, in such manner that the ship rides by one during the flood, and by the other during the ebb.

*To* Moor *Head*, or *Head* and *Stern*. This operation may be performed by two methods:—A ship may be secured by anchors before her, without any behind; or she may have anchors out, both before and behind her; or her cables may be attached to posts, rings, or moorings, which answer the same purpose. When a ship is moored by the head with her own anchors, they are disposed according to the circumstances of the place where she lies, and the time she is to continue therein. Thus, whenever a tide ebbs and flows, it is usual to carry one anchor out towards the flood, and another towards the ebb, particularly where there is little room to range about; and the anchors are laid in the same manner, if the vessel is moored head and stern in the same place. The situation of the anchors in a road or bay, is usually opposed to the reigning winds, or to those which are most dangerous, so that the ship rides therein with the effort of both her cables. Thus, if she rides in a bay or road which is exposed to a northerly wind and heavy sea from the same quarter, the anchors passing from the opposite bows, ought to lie east and west from each other; hence both the cables will retain the ship in her station with equal effort against the action of the wind and sea.

**MOORE, Sir Jonas**, a respectable mathematician, fellow of the Royal Society, and surveyor-general to the ordnance, was born at Whitby, in Yorkshire, in 1620. He was author of several works, but is more deservedly remembered for the support and protection which he rendered to the science, than for any immediate improvement or discovery of his own; the important offices that he filled engaging too much of his time to allow him to follow the subject so far as he might otherwise have done. To him we owe the first establishment of the Royal Observatory at Greenwich, and the appointment of Mr. Flamstead to that important office; as also for the institution of the mathematical school belonging to Christ Hospital; for the use of which, he composed a part of a mathematical course, but died before it was completed, about the year 1681.

**MOORINGS**, are an assemblage of anchors, chains, and bridles, laid athwart the bottom of a river or harbour, to ride the shipping therein. These anchors have generally but one fluke, which is sunk in the river near low-water mark. Two anchors, being thus fixed, on the opposite sides of the river, are furnished with a chain extending across from one to the other; in the middle of which is a large square link, whose lower end terminates in a swivel, to which are attached the bridles, which are short pieces of cables well served, whose upper ends are drawn into the ship, and secured to the bitts, &c. By this means the vessel veers round very readily, according to the change of the wind or tide; in some places, however, particularly in rivers, each ship takes in a bridle astern, also, by which she becomes moored head and stern.

**MOOT**, a difficult case argued by the young barristers and students at the inns of court, by way of exercise, the better to qualify them for practice, and to defend the causes of their clients.

**MORALITY**, the science and doctrine of morals, otherwise called ethics.

**MORAVIANS**, a denomination of Christians, whose episcopal and church government is conducted with great form and regularity. Questions of dispute are settled by ballot, and in cases of real or supposed importance are often decided by lot; the lot is deemed a solemn appeal to heaven, and is made use of with great seriousness. They have œconomies, or choir-houses, where they live together in community; the single men and single women apart, widows and widowers apart, each under superintendence of elderly persons of their own class. The Moravians are very strict in their attention to the youth of both sexes, and never suffer them to come together, or marry without the previous consent of the church, and as the lot must be cast to sanction their union, each receives his partner as a divine appointment. In doctrine the Moravians appear to be inclined to Sabellianism. They address all their prayers to Jesu, or the Lamb. They reject the use of the term Trinity. In zeal tempered with modesty, and in silent perseverance in attempting to convert the heathen world to Christianity, they were unequalled, having formed for this purpose settlements in Greenland, America, the West Indies, the Cape of Good Hope, the East Indies, &c.

**MORBID**, among Physicians, signifies diseased or corrupt, a term applied either to an unsound constitution, or to those parts or humours that are infected by a disease.

**MORDANT**, in Dyeing. When a substance to be dyed has little or no attraction to the matter on which the colour depends, so as either not to be capable of abstracting it from its solvent, or of retaining it with such force as to form a permanent dye, then some intermediate substance is used which acts as a bond of union between them: this substance is called a mordant.

**MOREL.** *Phallus Esculentus.*—The morel grows in wet banks and moist pastures. It is used by the French cooks, the same as the truffle, for gravies, but has not so good a flavour: it is in perfection in May and June.

**MORMYRUS**, a genus of fishes of the order abdominales. There are nine species, mostly inhabitants of the river Nile.

**MOROCCO**, a fine kind of leather, prepared of the skin of an animal of the goat kind, and formerly imported from the Levant, Barbary, &c. but now made in England.

**MOROXYLATES**, in Chemistry, a genus of salts, of which there are two species, *viz.* 1. The moroxylate of lime, found on the bark of the mulberry-tree, crystallized in short needles. Its taste resembles succinic acid. When heated, it swells, and emits a vapour which irritates the organs of smell. Its solution precipitates acetate of lead, nitrate of silver, and nitrate of mercury. 2. M. of ammonia, obtained by pouring carbonate of ammonia into the solution of the moroxylate of lime. This solution, when evaporated, yields crystals of moroxylate of ammonia in long slender prisms.

**MOROXYLIC Acid**, discovered by Dr. Thompson on the bark of the morus alba, or white mulberry, growing at Palermo in Sicily. It has the taste of succinic acid; is not altered by exposure to the air; but dissolves readily in water and alcohol. It does not precipitate the metallic solutions like its salt.

**MORRO**, is a term for headland or promontory on the coasts of Chili and Peru, in South America, on the South Pacific Ocean.

**MORTALITY, Bills of**, registers of the number of deaths or burials in any parish or district. The London bills of mortality are founded upon the reports of the sworn searchers, who view the body after decease, and deliver their report to the parish clerk. The parish clerks are required, under a penalty for neglect, to make a weekly return of burials, with age, and disease of which the person died, a summary of which account is published weekly; and on the Thursday before Christmas-day, a general account is made up for the whole year. The total number of parishes now comprehended in the London bills of mortality is 146. They are divided into ninety-seven parishes within the walls, sixteen parishes without the walls, twenty-three out parishes in Middlesex and Surrey, and ten parishes in the city and liberties of Westminster. They give the ages at which the persons die, a list of the diseases and casualties by which their death was occasioned; but little dependence can be placed upon the list of diseases, except with respect to some of the most common and determinate.

**MORTAR**, a preparation of lime and sand mixed up with water, which is served as a cement, and is used by masons and bricklayers in building of walls of stone and brick. *See* Lime. The best mortar for resisting water is made by mixing with lime, puzzolano, a volcanic sand brought from Italy. Basaltes may be substituted in its stead.

**Mortar**, in Chemistry and Pharmacy, an utensil very useful for the division of the bodies by percussion, trituration, &c. Mortars are of different shapes and sizes, and the matter intended to be broken in them is struck with a pestle made of wood, iron, or marble, according to the different degrees of hardness.

**MORTAR**, a piece of artillery, shorter and wider than a cannon, and having a chamber less than the size of its bore. It is used to discharge bombs, or shells and carcasses into a fortified place. The bomb, or shell, is a great hollow ball filled with powder, which falling into a fortification, &c. destroys the most substantial buildings by its weight, and, bursting asunder, creates the greatest mischief and disorder by its splinters. To prevent the shell from bursting at the first moment of discharge, it is furnished with a fuse, which continues burning during its flight; and to increase the weight of its fall, the mortar is elevated to a considerable angle above the horizon. The interior part of this piece of artillery is called the bore, wherein the bomb is lodged; the inner part of the bore, which is diminished towards the breech, and contains the powder, is termed the chamber. The chambers of mortars are extremely different in their figures, and each of these figures is defended by better or worse arguments. Thus they are spherical, cylindrical, conical, bottled, or concave. Indeed, nothing appears to be less determined upon true principles or experiments than the proportions of the several parts of a mortar. As the sea mortars, or those which are placed in the bomb-vessels, are generally fixed at a much greater distance from the object than is required at shore, they are made somewhat longer and much heavier than the land-mortars. Mr. Muhler, in his Treatise on Artillery, very justly observes, that the breech of our thirteen-inch sea-mortars is loaded with an unnecessary weight of metal: the chamber thereof contains thirty-two pounds of powder, and at the same time they are never charged with more than twelve or fifteen pounds by the most expert officers, because the bomb-vessel is unable to bear the violent shock of their full charge. Thus the action of the powder is diminished by the vacancy left in the chamber, which is never half filled. As a charge of twelve or fifteen pounds at most is therefore sufficient, it is evidently proved, by the theory of powder, that this will produce the greatest effect when discharged from a mortar with a cylindrical chamber. He also proves, by a variety of experiments made by Captain Desaguliers and himself, that the conical chamber, now used, is considerably inferior to the cylindrical one with the last discharge of powder. To facilitate the use of the mortar, it is placed in a solid carriage of timber called the bed, whose different parts are strongly bolted together. By means of this it is firmly secured in its situation, so that the explosion of the powder may not alter its direction. In the middle of the upper side of this carriage are two semicircular notches to receive the trunnions; over these are fixed two very strong bands of iron, called the cap squares, the middle of which is bent into a semi-circle, to embrace the trunnions, and keep them fast in the mortar bed. The cap-squares are confined to the timber work by strong pins of iron, called the eye-bolts, into whose upper ends are driven the keys, chained beneath them. On the fore-part of the bed a piece of timber is placed transversely, upon which rests the belly of the mortar on that part which contains the chamber. The elevation of this piece, which is called the bed bolster, is used to elevate and support the mortar whilst firing. These beds are placed upon very strong beds of timber, which are fixed in the bomb-ketch. They are securely attached to the frames by means of a strong bolt of iron called the pintle, passing perpendicularly through both, and afterwards through one of the beams of the vessel. Thus the pintle which passes through the whole in the centre, serves as an axis to the bed, so that the mortar may be turned about horizontally as occasion requires. The shell, as already observed, is a great hollow ball, charged with powder. The lower part of the shell is thickest, by which it becomes heavier on that side, and accordingly falls thereon, and never on the fuse. It is also the better enabled thereby to resist the impression of the powder, by which it is discharged from the mortar. Both of these reasons, however, Mr. Muhler conceives to be immaterial, because nothing but an absolute stoppage of the air can exhaust the fuses, as their composition enables them to burn in water as well as in air or earth, and the explosion of the mortar would not, in his opinion, be able to break them, if they were equally thick every where. The most proper quantity of powder to charge a shell is probably two-thirds of the weight which would fill the cavity. The fuse is generally a conical tube formed of birch, willow, or some dry wood, and filled with a composition of sulphur, salt-petre, and mealed powder. The shell being charged, this fuse is inserted in the cavity through the fuse-hole, and when fired, communicates the fire to the powder in the shell. The fuses are charged with great care, that nothing may prevent them from communicating the fire to the powder in the centre of the bomb. They are driven into it so as that only an inch and a half comes out beyond the fuse-hole, and then the shell is said to be fixed. These fuses are also charged long before there is occasion to use them; and that the composition with which they are filled may not fall out or be damaged by growing damp, the two ends are covered with a composition of tallow mixed either with pitch or bees-wax. When the fuse is to be put into the shell, the little end is opened or cut off, but the great end is never opened till the mortar is to be fired. The proper quantity of gunpowder being put into the chamber, if there be any vacant space, they fill it up with hay: some choose a wooden plug; over this they lay a turf, some a tompion fitted to the bore of the piece, and lastly the bomb, taking care that the fire be in the axis thereof, and the orifice be turned from the muzzle of the piece. What space remains is to be filled up with hay, straw, turf, &c. so as that the load may not be exploded without the utmost violence. This done, the charge is covered with a wad well beat down with the rammer. After this the fixed shell is placed upon the wad, as near the middle of the mortar as possible, with the fuse-hole uppermost, and another wad pressed down close upon it, so as to keep the shell firm in its position. The officer then points the mortar, or gives it the inclination necessary to throw the shell to the place designed. When the mortar is thus fixed, the fuse is opened; the priming-iron is also thrust into the touch-hole of the mortar to clear it, after which it is primed with the finest powder. This done, two of the matrosses or sailors, taking each one of the matches, the first lights the fuse, and the other fires the mortar. The shell, thrown out by the explosion of the powder, is thrown to the place intended; and the fuse, which ought to be exhausted at the instant of the shell's falling, inflames the powder contained therein, and bursts it into splinters; which, flying off circularly, occasion incredible mischief wheresoever they reach.

The following are the necessary orders before a bombardment by sea:—When any fixed shells are issued from the tenders, the artillery people on board are immediately to fix others in their room, and are always to keep in their tenders the same number they had at first. 2. The shells are to be fixed in the boats appointed to carry them, provided the weather permits; otherwise, in the safest place on deck, and to be kited or lowered down into a spare rack, which must be in each boat for that purpose. While the shells are fixing, the powder-room is to be shut, the hatches laid and well secured against fire, and the place where they are fixed is to be well watered. 3. The shells being carefully examined, in order that no spike be left therein, by which the fuse may be split, the fuses are to be cut the whole length, and to be set home into the shells very strongly. 4. No shells fixed during the service are to be kited; but if any should be left when the service is over, they are immediately to be kited. 5. The powder in the bomb-vessels is to be used first, and none to be opened or measured out except in the captain's cabin, the door of which is to be kept shut during the whole time, and covered with tanned hides to make it as secure as possible. 6. The fixed shells in the boats are to be likewise covered from fire or wet, with hair-cloth and tanned hides with the utmost care. 7. If the service is carried on at night, all the powder is to be ready measured out in cartridges, which may be kept in the powder-magazine and captain's cabin in the empty powder barrels and powder bags; and all the shells requisite to be ready. The tin tubes, one powder horn, and the port-fires, also the punches and bits for the vents, are to be kept in the captain's cabin. 8. No fire, nor light, except match and port-fires, to be on board either bomb-vessel or tender during the service. 9. The captain's cabin and the passage to it, also the way to the magazine and decks, are to be constantly watered. 10. The sponges for the mortars are to be all examined and tried, and if too large, they are to be cut so as to enter easily. 11. The vents of the mortars are to be examined, and the punches and tubes tried in them. 12. A laboratory chest is to be on board each bomb-vessel in the captain's cabin, in which all the small stores are to be kept. 13. Two tubs of water are to be on deck for the lightest port-fires and match, which must be constantly held in them till ordered to fire. 14. Two careful men are also to be appointed for this service, who are to do nothing else on any account. 15. Two careful men of the artillery are to be left on board each tender, for the filling and fixing of the shells. 16. Application must be made to the admiral for two men-of-war's boats to attend on each bomb-ketch and tender for carrying shells and stores. One of these is to be loaded with fixed shells, which, when sent to the bomb-vessel, must remain with her until they are all taken out, which should be only as they are wanted for loading the mortars: it is then to return to the tender. The other boats, meanwhile, will be receiving more fixed shells, and on the signal given from the bomb-ketch for more shells, must immediately repair to her with them. 17. A gang of warrant officers and eight seamen are to be at each mortar, and to give whatever assistance may be required. 18. A gang from the navy, with a careful warrant officer and non-commissioned officer of the artillery, are to have the charge between decks on board each bomb-vessel and tender, to get up the fixed shells that are in the rack, and a careful person is to remain constantly at the powder-room door, which must be kept shut as much as possible. 19. When any powder is wanted from the tender for loading the mortar, it should be measured out in the tender, and a proper charge put into paper cartridges, upon which should be written the quantity and the mortar for which it is allotted.

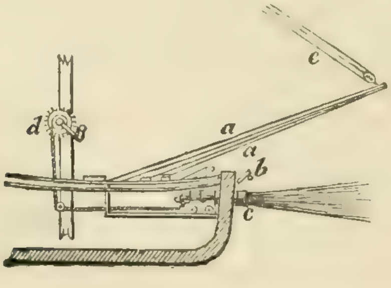
In shooting with mortars, the following general rules should be always observed:—1. To measure the distance of the object aimed at. 2. That the bombs be of equal weight, otherwise the shots will vary. 3. That the carriage be on an exact level to prevent its leaping. 4. That the powder with which the piece is charged be always of the same strength and quantity. 5. That the charge be always equally rammed down. 6. That the wads be always of wood, tompions, or oakum. 7. That the fuses be fresh made the days on which they are to be used, and that they be of a composition proportionable to the range of the shot in the air, so that the bomb may break at the very moment of, or soon after, its fall; which composition must be such as not to be extinguished though it fall in water, but continue burning till the bomb breaks.—If the service of mortars should render it necessary to use pound shots, two hundred of them, with a wooden bottom, are to be put into the thirteen-inch mortar, and a quantity of powder not exceeding five pounds; and one hundred of the above shot, with two pounds and a half of powder for the ten-inch mortar, or three pounds at most. One inch of fuse burns four seconds and forty-eight parts.

The following table exhibits the weight of the sea-mortars and shells, and also of their full charge:—

| Nature of the mortar. | Powder contained in the chamber when full. | | Weight of the mortar. | | | Weight of the shell when fixed. | Weight of powder contained in the shell. | |
|---|---|---|---|---|---|---|---|---|
| | lb. | oz. | C. | qr. | lb. | lb. | lb. | oz. |
| 10-inch howitzer. | 12 | 0 | 31 | 2 | 26 | 0 | 0 | 0 |
| 13-inch mortar.. | 30 | 0 | 81 | 2 | 1 | 198 | 7 | 0 |
| 10-inch mortar.. | 12 | 0 | 34 | 2 | 11 | 93 | 0 | 0 |

The Howitzer is a sort of mortar, which is to be fixed horizontally like a cannon, and has, like the cannon, a wheel carriage. These pieces are very rarely used in the sea service. For further particulars, see the articles Bomb, Range, &c.

Mortar.—*Mr. Carey's Improved Plan of a Gun and Mortar Boat, with Sheer Bowsprit.* A port-hole is cut through, and a port fitted, the same as the lower deck port. Combings and gratings are fitted over the gun, which runs in until wanted to the main mast. Over the gratings, a tarpauling is thrown in bad weather; alongside of the mast, a winch, which runs the gun in and out, and hoists the mainsail and foresail, and also tops the sheer bowsprit up when about to fire the gun. With two men, a boy, and an engineer, having a steam-engine on board, and a long 32-pounder with a chamber in the gun, a frigate might be destroyed in a calm, or a seventy-four dismasted and sunk. With a steam-engine on board, and if the larger vessel attempted to hoist out their boats to board the mortar boat, she could run away from them; and, a gun fitted right aft, could destroy the boats and their crews. The sheer bowsprits shew their utility, as no bowsprit shrouds are wanting, nor bobstay, the jib-tack forming the bobstay. Carey, of Bristol, fitted a boat in this way, when at his majesty's yard at Gibraltar, which Lord Nelson highly approved of.



*Description.* *a a* the sheer bowsprit; *b* the port and port-hole; *c* the 32 long pounder, with a chamber; in bad weather the gun is run under a grating which is over it upon deck; *d* a winch to heave the gun out and in; after firing, hoist the main sail, and heave up the sheer bowsprit; *e* the jib-stay and topping lift, to raise the sheers when going to fire.—N. B. A magazine is placed midway between the gun and the ship's side, which cannot be shewn in the above view.

**MORTGAGE**, signifies a pawn of lands or tenements, or any thing immoveable, laid or bound for money borrowed, to be the creditor's for ever, if the money be not paid at the day agreed upon. Mortgages are either in fee or for term of years, and the mortgager was formerly considered as tenant at will to the mortgagee, but he is now considered to have no legal estate whatever in the land. The last and best improvement of mortgages is the mode now adopted, where the mortgage is made for a term of years, that the mortgager, if he has also the fee, covenants to convey the fee to the mortgagee and his heirs, or any person whom he may appoint in case of default in payment of the money. Although, after breach of the condition, the estate is absolute at common law in the mortgagee, yet a right of redemption subsists in equity, which is called the equity of redemption, from the benefit of which the heir of the mortgager cannot be excluded by any covenant, provided the original intent is to morgage the estate, and not to sell it at first. This right goes to those who would have had the estate, if it had not been incumbered. Although therefore the mortgage is forfeited, yet a court of equity will allow the mortgager at any reasonable time, to recall or redeem the estate, paying the principal, interest, and costs. This, however, is not allowed, if the mortgagee has been twenty years in possession. The heir at law may have the mortgage redeemed out of the personal assets in the first place as far as they will extend. This privilege is also allowed to the person to whom land mortgaged is devised. Where a mortgager conceals prior incumbrances upon making a second mortgage, he loses the equity of redemption.

**MORTISE**, or Mortoise, in Carpentry, a kind of joint, wherein a hole of a certain depth is made in a piece of timber, which is to receive another piece called a tenon.

**MORTMAIN**, signifies an alienation of lands and tenements, to any guild, corporation, or fraternity, and their successors, as bishops, parsons, vicars, &c., which may not be done without the king's license, and the lord of the manor; or of the king alone, if it is immediately holden of him.

**MORUS**, the *Mulberry Tree*, a genus of the tetrandria order, in the monœcia class of plants; natural order scabridæ. There are seven species, *viz.* 1. The nigra, or common black-fruited mulberry-tree, rises with an upright, large, rough trunk, dividing into a branchy and very spreading head, rising twenty feet high or more. The fruit has the common qualities of the other sweet fruits, abating heat, quenching thirst, and promoting the grosser secretions; an agreeable syrup made from the juice is kept in the shops. The bark of the roots has been in considerable esteem as a vermifuge; its taste is bitter, and somewhat astringent. 2. The alba, or white mulberry-tree, rises with an upright trunk, branching twenty or thirty feet high. Considered as fruit trees, the nigra is the only proper sort to cultivate here; the trees being not only the most plentiful bearers, but the fruit is larger and much finer flavoured than that of the white kind. Mulberry-trees are noted for their leaves affording the principal food of the silkworm. The leaves of the white species are preferred for this purpose in Europe; but in China, where the best silk is made, the worms are fed with those of the morus tartarica. The advantages of white mulberry trees are not confined to the nourishment of worms: they may be cut every three or four years like sallows and poplar trees to make fagots; and the sheep eat their leaves in the winter, before they are burnt. This kind of food, of which they are extremely fond, is nourishing; it gives a delicacy to the flesh and a fineness to the wool. The paper mulberry, is so called from the paper chiefly used by the Japanese being made of the bark of its branches. The leaves of this species also serve for food to the silkworm, and is now cultivated with success in France. It thrives best in sandy soils, grows faster than the common mulberry, and at the same time it is not injured by the cold. The inhabitants of Japan make paper of the bark, cultivate the trees to this purpose on the mountains, much after the same manner as osiers are cultivated with us, cutting down the young shoots in December, after the leaves are fallen; these being divided into rods of three feet in length, are gathered in bundles to be boiled; they are placed erect and close in a large copper, properly closed, and the boiling continued till the separation of the bark shews the naked wood, after which, by a longitudinal incision, the bark is stripped off and dried, the wood being rejected. To purify the bark, they keep it three or four hours in water; when it is sufficiently softened, the cuticle, which is of a dark colour, together with the greenish surface of the inner bark, is pared off, at the same time the stronger bark is separated from the more tender, the former making the whitest and best paper; the latter a dark and inferior kind. The finest and whitest cloth, worn by the principal people at Otaheite, and in the Sandwich islands, is made of the bark of this tree. The bread-fruit tree makes a cloth inferior in whiteness and softness, worn chiefly by the inferior people. Cloth is also made of a tree resembling the wild fig-tree of the West Indies; it is coarse and harsh, the colour of the darkest brown paper; but it is the most valuable, because it resists the water. This is perfumed and worn by the chiefs as a mourning dress in Otaheite. The tinctora is a fine timber tree, and a principal ingredient in most of our yellow dyes, for which it is chiefly imported into Europe.

**MOSAIC**, or Mosaic Work, an assemblage of little pieces of glass, marble, precious stones, &c. of various colours, cut square, and cemented on a ground of stucco, in such a manner as to imitate the colours of painting.

**MOSCHUS**, Musk, a genus of quadrupeds, of the order pecora. The Tibetian musk in size and general appearance resembles the small roebuck. It measures about three feet three inches in length, about two feet three inches in height from the top of the shoulders to the bottom of the fore feet, and two feet nine inches from the top of the haunches to the bottom of the hind feet. The upper jaw is considerably longer than the lower, and is furnished on each side with a curved tusk about two inches long. These tusks are of a different form from those of any other quadruped; being sharp edged on their inner or lower side, so as to resemble in some degree a pair of small crooked knives: their substance is a kind of ivory, as in the tusks of the baly russa and some other animals. They are hunted for the sake of their well-known perfume, which is kept in an small oval receptacle about the size of an egg, hanging from the middle of the abdomen, and peculiar to the animal. This receptacle is found constantly filled with a soft, unctuous, brownish substance, of the most powerful and penetrating smell, and which is no other than the perfume in its natural state. As soon as the animal is killed, the hunters cut off the receptacle or musk bag, and tie it up ready for sale. As musk is an expensive drug, it is frequently adulterated by various substances. As a medicine, it is held in high estimation in the Eastern countries, and has now been introduced into pretty general use, especially in those disorders which are commonly termed nervous; and in convulsive and other cases it is often administered in pretty large doses with great success. The Indian musk is rather larger than the common or Tibetian musk, of the colour mentioned in the specific character, with the head shaped like that of a horse, upright oblong ears, and slender legs. The pigmy musk is considerably smaller than a domestic cat, measuring little more than nine inches from the nose to the tail.

**MOSQUE**, a temple or place of religious worship among the Mahometans. All mosques are square buildings, generally built with stone; before the chief gate there is a square court, paved with white marble, and low galleries round it, whose roof is supported by pillars. In these galleries the Turks wash themselves before they go into the mosque. In each mosque there are a great number of lamps. As it is not lawful to enter the mosque with shoes or stockings on, the pavements are covered with pieces of stuff sewed together, each wide enough to hold a row of men kneeling, sitting, or prostrate. The women are not allowed to enter the mosques. About every mosque there are six high towers, called minarets, each of which has three little open galleries one above another: whence, instead of a bell, the people are called to prayer by certain officers appointed for that purpose. Most of the mosques have a kind of hospital belonging to them, in which travellers, of what religion soever, are entertained during three days. Each mosque has also a place called tarbe, which is the burying place of its founders; within which is a tomb six or seven feet long, covered with green velvet or satin, at the end of which are two tapers, and round it several seats for those who read the Koran, and pray for the souls of the deceased.

MOTACILLA, the *Wagtail* and *Warbler*, a genus of birds of the order of passeres, distinguished by a straight weak bill, and very slender legs.—The white wagtail frequents the sides of ponds and small streams, and feeds on insects and worms. The yellow wagtail migrates in the north of England, but in Hampshire continues the whole year. The male is a bird of great beauty; the breast, belly, thighs, and vent-feathers, being of a most vivid and lovely yellow. The colours of the female are more obscure than those of the male; it wants also those black spots on the throat. Under this genus there are several well known birds, which we shall here describe. The gold crested wren belongs to this class, a native of Europe, and of the correspondent latitudes of Asia and America, is the least of all the European birds, weighing only a single drachm. Its length is about four inches and a half, and the wings when spread out measure little more than six inches. On the top of its head is a beautiful orange-coloured spot, called its crest, which it can hide at pleasure.—The tailor bird, belonging also to this class, is a native of the East Indies. It is remarkable for the art with which it makes its nest, seemingly in order to secure itself and its young in the most perfect manner possible against all dangers from voracious animals. It picks up a dead leaf, and sews it to the side of a living one; its slender bill is the needle, and its thread is formed of some fine fibres; the lining is composed of feathers, gossamer, and down.—The nightingale, another of this genus, exceeds in size the hedge sparrow. The bill is brown; the irides are hazel; the head and back pale tawny, dashed with olive; the tail is of a deep tawny red; the under parts pale ash colour, growing white towards the vent; the quills are cinereous brown. The male and female are very similar. This bird, the most famed of the feathered tribe, for the variety, length, and sweetness of its notes, is supposed to be migratory. The female builds in some low bush or quickset-hedge well covered with foliage, for such only this bird frequents, and lays four or five eggs of a greenish brown. The nest is composed of dry leaves on the outside, mixed with grass and fibres, lined with hair or down within, though not always alike. The female alone sits on and hatches the eggs, while the male, not far off, regales her with his delightful song; but as soon as the young are hatched, he commonly leaves off singing, and joins with the female in the task of providing for and feeding them.—The hedge-sparrow, a well-known bird, has the back and wing-coverts of a dusky hue, edged with reddish-brown, rump of a greenish-brown; throat and breast of a dull ash-colour; the belly a dirty white; and the legs of a dull flesh-colour. The note of this bird would be thought pleasant, did it not remind us of the approach of winter.—The redstart is somewhat less than the redbreast; the forehead is white; the crown of the head, hind part of the neck, and back, are deep blue-gray; the cheeks and throat black; the breast, rump, and sides red; and the belly is white; the two middle tail feathers are brown; the rest red; and the legs are black. The wings are brown in both sexes. The red-breast, universally known, builds not far from the ground, if in a bush; though sometimes it fixes on an out-house, or retired part of some old building. The nest is composed of dried leaves, mixed with hair and moss, and lined with feathers. The eggs are of a dusky white, marked with irregular reddish spots; and are from three to seven in number. insects are their general food; but in defect of these they will eat many other things. No bird is so tame and familiar as this; closely attending the heels of the gardener when he is using his spade, for the sake of worms; and frequently in winter entering houses where windows are open, when they will pick up the crumbs from the table while the family is at dinner. The wheatear is in length five inches and a half. The top of the head, hind part of the neck, and back, are of a bluish gray; and over the eye a streak of white; the under parts of the body yellowish-white; the breast tinged with red; and the legs are black. This bird is met with in most parts of Europe, even as far as Greenland; and specimens have also been received from the East Indies. The young are hatched in the middle of May. In some parts of England these birds are in vast plenty.

The wren is a very small species, in length only three inches and three-quarters, though some have measured four inches. It generally carries the tail erect. This minute bird is found throughout Europe; and in England it defies our severest winters. Its song is much esteemed, being, though short, a pleasing warble, and much louder than could be expected from the size of the bird; it continues throughout the year.—Above an hundred and fifty species, besides varieties, are enumerated by ornithologists as belonging to this genus.

**MOTE**, in Law-books, signifies court, meeting, or convention, as a ward-mote, burg-mote, swain-mote, &c.

**MOTH**, in Zoölogy, is an insect of the winged kind, which, though insignificant in itself, proves destructive to various crops of garden and field productions. Of these insects there is a great variety, and their natural history is both amusing and instructive.

**MOTHER of Pearl**, is that beautiful natural white enamel, which forms the greater part of the substance of the oyster-shell, particularly of the pearl oyster.

Mother *Water*, in Chemistry, is the uncrystallizable residue of a compound saline solution: thus the liquor left in a salt pan after the salt is taken out, is the mother-water.

**MOTION**, or Local Motion, in Mechanics, is a continued and successive change of place, or it is that affection of matter by which it passes from one point of space to another. Motion is of various kinds, as follows:

*Absolute* Motion, is the absolute change of places in a moving body, independent of any other motion whatever; in which general sense, however, it never falls under our observation. All those motions which we consider as absolute, are in fact only relative; being referred to the earth, which is itself in motion. By absolute motion, therefore, we must only understand that which is so with regard to some fixed point upon the earth; this being the sense in which it is delivered by writers on this subject.

*Accelerated* Motion, is that which is continually receiving constant accessions of velocity. *See* Accelerated *Motion.*

*Angular* Motion, is the motion of a body as referred to a centre, about which it revolves.

*Compound* Motion, is that which is produced by two or more powers acting in different directions. *See* Parallelogram of *Forces.*

*Equable* Motion, or *Uniform Motion,* is when the body moves continually with the same velocity, passing over equal spaces in equal times.

*Natural* Motion, is that which is natural to bodies, or that which arises from the action of gravity

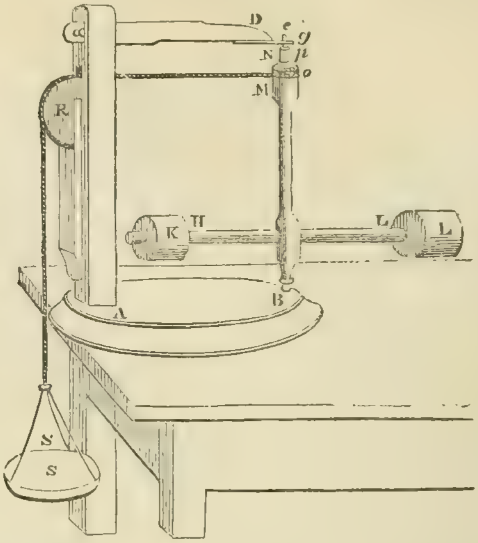
*Relative* Motion, is the change of relative place in one or more moving bodies; thus two vessels at sea are in *absolute motion* (according to the qualified signification of this term) to a spectator standing on shore, but they are only in relative motion with regard to each other.

*Retarded* Motion, is that which suffers continual diminution of velocity, the laws of which are the reverse of those for accelerated motion. *See* Acceleration and Retardation.

*Projectile* Motion, is that which is not natural, but impressed by some external cause; as when a ball is projected from a piece of ordnance, &c. *See* Projectile.

*Rectilinear* Motion, that which is performed in right lines.

*Rotatory* Motion.—*Seaton's Machine for Experiments on Rotatory Motion.* This machine is exhibited in the following figure, where the vertical axis N B is turned by the rope M passing over the pulley R, and carrying the scale S. The axis N B carries two equal leaden weights K, D, moveable at pleasure on the horizontal bar H I. The upper part N of the axis is one half the diameter of the part M, so that when the rope is made to wind round N, it acts at half the distance from the axis, at which it acts when coiled round M. When the rope is wound round N, the same force will produce in the same time but half the velocity which is produced when the rope coils round M, the situation of the leaden weights being the same; but when the weights K, L, are removed to a double distance from the axis, a quadruple force will be required in order to produce an equal angular velocity in a given time.



*Laws* of Motion, as delivered by Newton in his "Principia," and on which he has supported the whole system of his philosophy, are the three following:

Every body perseveres in its state of rest, or uniform motion in a right line, until a change is effected by the agency of some external force. Any change effected in the quiescence or motion of a body is in the direction of the force impressed, and is proportional to it in quantity. Action and reaction are equal, and in contrary directions.

When speaking of these axioms, or laws of motion, it ought always to be recollected that they are not the efficient operative causes of any thing. A law presupposes an agent; for it is only the mode, according to which an agent proceeds: it implies a power, for it is the order according to which that power acts. Abstracted from this agent, this power, the law does nothing, is nothing; so that a law of nature or of motion can never be assigned as the adequate cause of phenomena, exclusive of power and agency. The Newtonian axioms are, in reality, intermediate propositions between geometry and philosophy; through which mechanics becomes a mathematical branch of physics, and its conclusions possessed of such coherence and consistency among themselves, and with matter of fact, as are rarely to be found in other branches, which admit not of so intimate a union with the science of quantity.

The evidences from which our assent to these axioms is derived, are of various kinds:—1. From the constant observation of our senses, which tend to suggest the truth of them in the ordinary motion of bodies, as far as the experience of mankind extends. 2. From experiments, properly so called. 3. From arguments *à posteriori.* One or other of these kinds of evidence generally forms a part of our most valuable treatises on mechanics and physics; but there is a fourth way in which the truth of these axioms may be deduced, which is that in which they are shewn to be laws of human thought, intuitive consequences of the relations of those ideas which we have of motion, and of the causes of its production and changes.

Motion, in Astronomy, is still farther divided into *diurnal, annual, horary, sidereal,* &c.; for which see the respective terms.

Motion, *Spontaneous* or *Muscular,* is that performed by the muscles at the command of the will.

Motion, *Natural* or *Involuntary,* that effected without any such command, by the mere mechanism of the parts, such as the motion of the heart, pulse, &c.

Motion, *Intestine,* the agitation of the particles of which a body consists.

Motion, in Music, the manner of beating the measure, to hasten or slacken the time of the words or notes.

MOTRIX, that which has the power or faculty of moving.

MOULD, or Mold, in the Mechanic arts, &c. a cavity cut with a design to give its form or impression to some softer matter applied therein, of great use in sculpture, foundery, &c.

Mould, a thin flexible piece of timber, used by shipwrights as a pattern whereby to form the different curves of the timbers, and other compassing pieces in a ship's frame; of these there are two sorts, the bend-mould and the hollow-mould. The former of these determines the convexity of the timbers, and the latter the concavity on the outside, where they approach the keel, particularly towards the extremities of the vessel. The figure given to the timbers by this pattern is called the Bevelling. See that article.

Moulds, in the manufacture of paper, are little frames composed of several brass or iron wires, fastened together by another wire still finer. Each mould is of the bigness of the sheet of paper to be made, and has a rim or ledge of wood to which the wires are fastened; these moulds are more usually called frames or forms.

Moulds *for Leaden Bullets*, are little iron pincers, each of whose branches terminates in an hemispherical concavity, which when shut forms an entire sphere; in the lips or sides, where the branches meet, is a little jet or hole through which the melted lead is conveyed.

Moulds, *Glaziers'*. The glaziers have two kinds of moulds, both serving to cast their lead. In the one they cast the lead into long rods or canes fit to be drawn through the vice, and the grooves formed therein; this they sometimes call ingot mould. In the other they mould those little pieces of lead a line thick, and two lines broad, fastened to the iron bars; these may be also cast in the vice.

Moulds, among plumbers, are the tables whereon they cast the sheets of lead. These they sometimes call simple tables; besides which they have other real moulds wherewith they cast pipes without soldering.

Moulds, used in basket-making, are very simple, consisting ordinarily of a willow or osier, turned or bent into an oval, circle, square, or other figure, according to the baskets, panniers, hampers, hats, and other utensils intended.—On these moulds they make, or, more properly, measure all their work, and accordingly they have them of all sizes, shapes, &c.

Moulds, among tallow-chandlers, are of two kinds: the first for the common dipped candles, being the vessel wherein the melted tallow is disposed, and the wick dipped; this is of wood of a triangular form, and supported on one of its angles, so that it has an opening of near a foot at top: the other, used in the fabric of mould candles, is of brass, pewter, or tin; here each candle has its several moulds.

Mould, among gold-beaters, a certain number of leaves of vellum, or pieces of gut cut square, of a certain size, and laid over one another, between which they put the leaves of gold and silver, which they beat on the marble with the hammer. They have four kinds of moulds, two whereof are of vellum, and two of gut; the smallest of those of vellum consists of forty or fifty leaves, the largest contains an hundred; for the others, each contains five hundred leaves. The moulds have all their several cases, consisting of two pieces of parchment, serving to keep the leaves of the mould in their place, and prevent their being disordered in beating.

Mould, in Agriculture, a loose kind of earth every where obvious on the surface of the ground; called also natural or mother earth; by some also, loam.

MOULDINESS, a term applied to bodies which corrupt in the air, from some hidden principle of humidity therein, and whose corruption shews itself by a certain white down, or lanugo, on their surface, which viewed through a microscope appears like a kind of meadow, out of which arise herbs and flowers, some only in the bud, others full blown, and others decayed, each having its root, stalk, and other part. *See* Mucor.

MOULDING, any thing cast in a mould, or that seems to have been so, though in reality it were cut with the chisel or the axe.

MOULDINGS, in Architecture, projections beyond the naked wall, column, wainscot, &c.

MOUNTAIN Blue. The substance called mountain blue, is one of the native varieties of carbonate of copper, of which there are three, the green, the blue, and the anhydrous. The following is the order of their compositions:—

| | 1st. | | 2d. | | 3d. |
|---|---|---|---|---|---|
| Carbonic acid ............ | 2·75 | ...... | 11·00 | ...... | 2·57 |
| Deutoxide of copper...... | 10·00 | ...... | 30·00 | ...... | 10·00 |
| Water.................... | 1·125 | ...... | 2·25 | ...... | 0·00 |

The blue carbonate is found in great perfection at Chessy, near Lyons; also in Bohemia, Saxony, &c. It occurs crystallized, in rhomboids, and imperfect octohedra. It also is found in small globular masses, massive and earthy. The earthy variety is called copper azure or mountain blue. The green variety is called malachite, it is found in various forms, but never regularly crystallized, the octohedral variety being a pseudo-crystal derived from the decomposition of the red oxide. This mineral occurs in the greatest beauty in the Uralian mountains of Siberia: it is rarely found in Cornwall. It is of various shades of green, and often cut into small slabs, or used as beads and brooch-stones; the pulverulent variety has been termed chrysocollæ and mountain green. There is a very fine blue cupreous preparation called refiner's verditer, principally made by silver refiners. It consists of three proportionals of oxid, four of carbonic acid, and two of water. There is a very inferior pigment, also called verditer, which is a mixture of sub-sulphate of copper and chalk. According to Pelletier, a good verditer may be obtained as follows: Add a sufficient quantity of lime to nitrate of copper, to throw down the hydrated oxide; it gives a greenish precipitate, which is to be washed and nearly dried upon a strainer; then incorporate with it from eight to ten per cent. of fresh lime, which will give it a blue colour, and dry it carefully. Proust obtained a fine blue carbonate of copper, by adding an alkaline carbonate to a solution of nitrate of copper. The artificial carbonates will probably not answer with every experimentalist. If not, the native mountain blue may possibly be obtained either under that name or copper azure.

MOUNTAINS. Elevations consisting of clay, sand, or gravel, are called hills; those which consist of stone are called mountains. Mountains are divided into primæval, that is, of equal date with the formation of the globe, and secondary or alluvial. Among primæval, those of granite hold the first place. The highest mountains and most extensive ridges throughout the globe are of that kind. The highest of them never contain metallic ores; but some of the lower contain ores of copper and tin. The granite next the ore always abounds in mica. Petrifactions are never found in these primæval mountains. That the formation of these mountains preceded that of vegetables and animals, is inferred from their containing no organic remains, either in the form of petrifaction or impression. Granites were formed by crystallization, an operation that probably took place after the formation of the atmosphere, and the gradual excavation of the bed of the ocean, when the dry land appeared. For by means of the separation of the aëriform fluids which constitute the atmosphere, the evaporation of part of the water into the atmosphere, and the gradual retreat of the remainder, the various species of earths, before dissolved or diffused through this mighty mass, were disposed to coalesce; and among these the siliceous must have been the first, as it is the least soluble; but as the siliceous earth has an affinity to the other earths with which it was mixed, some of these must have united in various proportions, and thus have formed in distinct masses, the feldtspar, schorl, and mica, which compose the granite.

Calcareous earth enters sparingly into the composition of this stone; but as it is found in schorl, which is frequently a component part of granite, it follows that it must be one of the primitive earths, and not entirely derived from marine exuviæ. Quartz cannot be a product of fire; for in a very low heat it bursts, cracks, and loses its transparency, and in the highest degree of heat that we can produce, it is infusible, so that in every essential point it is different from glass. As granite contains earth of every genus, we may conclude that all the simple earths are original. Mountains which consist of limestone or marble of a granular or scaly texture, and not disposed in strata, seem also to have preceded the creation of animals, for no organic traces are found in them. Some of those which consist of argillaceous stones, and some of the siliceous, contain also no organic remains.

Alluvial mountains are evidently of posterior formation, as they contain petrifactions and other vestiges of organic substances; and these are always stratified. Mountains, as to structure, are entire, stratified, and confused. Entire mountains are formed of huge masses of stone, without any regular fissures, and are mostly homogeneous. Stratified mountains are those whose mass is regularly divided by joints or fissures, these are called horizontal, rising, or dipping. Homogeneous stratified mountains consist chiefly of stones of the argillaceous genus, or of the fissile compound species of the siliceous genus, as metallic rock; sometimes of limestone of a granular or scaly texture, in which no animal vestiges appear. This limestone reposes on the argillaceous or siliceous strata; sometimes the argillaceous are covered with masses of granite, sometimes of lava. These mountains, particularly those of gneiss, metallic rock, and horn-stone, are the chief seat of metallic ores. Heterogeneous, or compound stratified mountains, consist of alternate strata of various species of stones, earths, sands, &c. The limestone here is always of the laminar, and not of the granular or scaly kind, and when it contains any ore, it is placed between its laminæ. Coal, bitumen, petrifactions, and organic impressions, are found in these mountains; also salts and calamine. There are other mountains which cannot be called stratified, as they consist only of three masses; the lowest granite, the middle argillaceous, and the upper limestone. Metallic ores are found in the argillaceous part, or between it and the limestone. Confused mountains consists of stones heaped together without order, their interstices being filled with clay, sand, and mica. They scarcely ever contain any ore. Besides these, these are many mountains in different parts of the world, which derive their origin from volcanoes. The height of mountains is usually calculated by means of the barometer. *See* BAROMETER. The highest mountains are those which are situated at or near the equator. The Himalaya and the Andes are generally allowed to be the highest of these. the line of congelation, or of perpetual frost on mountains, is calculated at 15,400 feet, at or near the equator; at the entrance of the temperate zone, at 13,428; at Teneriffe, at 1060; in Auvergne (lat. 45) 6,740; with us (lat. 52), 5,740. On the Andes, vegetation ceases at 14,497 feet; and on the Alps at 9,585. The air is so dry in these elevated situations, that M. d'Arcet observed, that on the Pic de Midi, one of the Pyrenees, salt of tartar remained dry for an hour and a half, though it immediately warmed in the same temperature at the bottom of the mountain.

MOUNTING, in Military affairs, signifies going upon duty. Thus, mounting a breach is running up to it; mounting the guard, is going upon guard; and mounting the trenches, is going upon duty in the trenches; but mounting a cannon, mortar, &c. is the setting it on its carriage, or the raising its mouth.

MOUSE, a sort of knob, wrought on the outside of a rope by means of spun-yarn, parsling, &c. *See* the article PUDDENING. It is particularly used on the stays, to prevent it from unhooking when the tackle is slackened.

MOUSE. *See* MUS.

MOVEABLE, in general, denotes any thing capable of being moved. The moveable feasts are such as are not regularly held on the same day of the year or month, though they are always on the same day of the week. Thus Easter, on which all the rest depend, is held on the Sunday which falls upon, or next after, the first full moon following the 21st of March.

MOVEMENT, in Mechanics, a machine that is moved by clock-work. *See* CLOCK.

MOVEMENT, in Military affairs. Under this term are comprehended all the different evolutions, marches, countermarches, and manoeuvres, which are made in tactics for the purpose of retreating from, or of approaching towards, an enemy. It also includes the various dispositions which take place in pitching a camp, or arranging a line of battle.

MOVEMENT, in Music, the name given to any single strain, or to any part of a composition comprehended under the same measure of time.

MUCIC ACID, was called saclactic acid from its having been found in the sugar of milk; but as oxalic acid is also found in milk, and this acid is found in all gums, it has been better distinguished by the name of mucic. It forms, with the oxides of metals, salts which are scarcely soluble.

MUCILAGE, a glutinous matter obtained from vegetables, transparent and tasteless, soluble in water, but not in spirits of wine. It chiefly consists of carbon, hydrogen, and a small quantity of oxygen. *See* GLUTEN.

MUCOR, in Botany, a genus of the order fungi, in the cryptogamia class of plants. There are seventeen British species. The lichnoides, or little, black, pin-headed mucor, grows in groups near to each other, in chasms of the barks of old trees, and upon old park-pales. The common gray mould, grows on bread, fruit, plants, and other substances in a putrid state. It grows in clusters; the stalks a quarter of an inch high, pellucid, hollow, and cylindrical, supporting each in a single globular head, at first transparent, afterwards dark-gray; which bursts with elastic force, and ejects small round seeds discoverable by the microscope. The yellow frothy mucor, is found on the leaves of plants, such as ivy, beech, &c. sometimes upon dry sticks, and frequently upon the tan or bark in hot-houses. It is of no certain size or figure, but of a fine yellow colour, and a substance at first resembling cream beaten up into froth. In the space of 24 hours it acquires a thin filmy coat, becomes dry, and full of sooty powder adhering to downy threads.

MUCUS, a fluid secreted by certain glands, and serving to lubricate many of the internal cavities of the body. In its natural state it is generally limpid and colourless; but from certain causes will often assume a thick consistence, and whitish colour, like pus; but strong sulphuric acid and water, diluted sulphuric acid, and caustic alkaline, lixivium, and water, will serve to distingush pus from mucus; the vitriolic acid separates it from coagulable lymph, and alkaline lixivium from serum. Thus when a person expectorates matter, the decomposition of which he wishes to ascertain, let him dissolve it in vitriolic acid, and in caustic alkaline lixivium; and let him add pure water to both solutions. If there is a fair precipitation in each, he may be assured that some pus is present. But if there is a precipitation in neither, it is a certain test that the mixture is entirely mucus. If the matter cannot be made to dissolve in alkaline lixivium by time and trituration, we have also reason to believe that it is pus.

MUCUS, NASAL, a name given to a liquid secreted in the cavities of the nose, and discharged outwardly, either by the nostrils or by the fauces when it descends by the posterior part of the nasal cavities, in which it is thrown out by spitting. This liquid, always exposed to the air, which continually passes through the nostrils, is thicker, more viscid, and more adhesive than the tears; and the carbonate of soda it contains, whilst the latter contains only soda, announces that the air deposits in it a part of the carbonic acid which it contains, especially as it is expired out of the lungs. When it becomes thick in the air, it frequently assumes in it the form of small, dry, brilliant, and as it were micaceous plates. The nasal mucus experiences no real putrifaction in the air. Water does not dissolve it. Acids thicken it when they are concentrated and employed in small proportions; but when we add a larger quantity, they re-dissolve, and give it different shades of colour. The mucus of the nostrils maintains the softness of the membranaceous sides of the nasal cavities. It moderates the too great sensibility of the nervous papillæ, stops and fixes the odorous bodies, and blunts their too great activity. It likewise purifies the air that is respired, by taking from it the pulverulent particles which it carries along with it, and which would be more hurtful in the lungs.

MUFFLE, in metallurgy, an arched cover, resisting the strongest fire, and made to be placed over coppels and tests in the operations of assaying, to preserve them from the falling of coals and ashes into them; though, at the same time, of such a form, as is no hinderance to the action of the air and fire on the metal, nor to the inspection of the assayer.

*To* MUFFLE *the Oars*, is to put some matting, &c. round that part of the oar which lies on the edge or gunnel of the boat, when rowing, to prevent its making a noise against the tholes.

MUFTI, or MUPHTI, the chief of the ecclesiastical order, or primate, of the Mussulman religion. His authority is very great.

In all actions, especially criminal ones, his opinion is required by giving him a writing, in which the case is stated under feigned names, which he subscribes with words, *He shall* or *shall not be punished*. Such outward honour is paid to the mufti, that the grand seignior himself rises up to him, and advances seven steps to meet him, when he comes into his presence. The election of the mufti is solely in the grand seignior.

MUGIL, Mullet, a genus of fishes of the order abdominales. Gmelin notices only five species. Shaw mentions nine. The common mullet is generally about 14 inches in length, and is found not only in the Northern and Mediterranean seas, but in the Indian and Western oceans. The mullets collect in multitudes almost close to the shores, thrusting their head into the soft muddy bottoms in quest of aquatic insects. On the approach of summer they ascend rivers to a considerable distance from the sea, to deposit their ova. They are regarded by many as excellent food, but are not often seen at the tables of the opulent.

MULBERRY. *See* Morus.

MULE, in zoology, a mongrel kind of quadruped, generated between an ass and a mare, and sometimes between a horse and a she-ass. The mule is a monster of a middle nature between its parents, and incapable of propagating its species. Mules are chiefly used in countries where there are rocky and stony roads, as about the Alps, Pyrenees, &c. No creatures are so proper for carrying large burdens, and none so sure footed. They will travel several months together with six or eight hundred weight upon their backs; they are much hardier and stronger than the horse, and will live and work twice his age.

Mules, among gardeners, denote a sort of vegetable monsters produced by putting the farina fecundans of one species of plant into the pistil or utricle of another. The signification of the word is likewise extended to every kind of animal produced by a mixture of two different species.

MULLERS for Grinding Colours, according to the common construction, are too well known and too simple to need a particular description here. But Rawlinson's *concave* muller, for which the Society of Arts presented him a silver medal and ten guineas, on account of its ingenuity, shall find a place here.—This machine has been used for several years, and has been found much more effectual and expeditious in reducing the colour to extreme fineness than the usual method, and much less injurious to the health of the workman, who frequently has done as much with it in three hours as he could in twelve with the muller and slab. The machine consists of a flat cylinder of black marble, sixteen inches and a half diameter, and four and a half thickness, with an axle traversing its centre, (thus somewhat resembling a common cutler's grindstone.) It is suspended on a similar frame, in a vertical position, and turned round in the same manner by a winch: a concave piece of marble is provided, of the same breadth as the circular stone, forming a segment of the same circle one-third of the circumference in extent: this, which may be considered as the muller, is fitted into a piece of solid wood of similar shape, one end of which is secured loosely by a hinge or otherwise to the frame; the other end, rising over the circular stone, and supported by it, is further pressed down on it by a long spring bent over from the opposite extremity of the stand, and regulated as to its pressure by a screw, whose end turns against the concave muller: a slight frame of iron in front, moveable on a hinge, by which it is secured to the frame, supports a scraper, for taking off the colour, formed of a piece of watch-spring, which is turned back out of the way when not in use. Mr. R. thinks the circular grindstones might be made much larger than he used, to advantage, and that one of two feet diameter would not occasion too much labour to one man to turn it: he computes that in his machine there are seventy square inches of surface of the concave muller in constant work on the paint, while in the common muller not more than sixteen square inches are usually in contact with the slab. The machine will be found equally serviceable for the colours ground in water as for those prepared with oil, according to Mr. R., who highly recommends its use to all colourmen. Mr. R. advises, in making up the colours in bladders, to insert a bit of quill or reed in the neck of the bladder, which will thus bind better in tying; and, admitting of a secure stopper, will be more cleanly and less wasteful than the usual method of stopping with a nail, and keep the colour more safe from the air.

MULLUS, Surmullet, a genus of fishes of the order thoracici. Gmelin reckons six, Shaw thirteen species. The red surmullet is principally found in the Mediterranean and North seas, where it arrives at the length of twelve or fifteen inches; its colour is a rose red, tinged with olive-colour on the back, and of a silvery cast towards the abdomen. It is generally considered as a very delicate fish, and is celebrated for having been the fashionable object of Roman luxury, and for which enormous sums are reported to have been sometimes given. The Romans practised a singular refinement in luxury, by first bringing the fish alive to the table, in a transparent vessel, in order that the guests might contemplate the beautiful and rapid changes of its evanescent colours during the time of its gradual expiration; after which, it was prepared for their repast.

MULTANGULAR, a figure, or body, which has many angles.

MULTILATERAL, in Geometry, is applied to figures which have more than four sides or angles.

MULTINOMIAL, or Multinomial *Roots*, in Mathematics, such roots as are composed of many names, parts, or members; as, $a + b + d + c$, &c. *See* Root.

MULTIPLE, in Arithmetic, is a number which contains another number a certain number of times; thus 18 is a multiple of 6, or of 3, or of 9, &c.

*Common* Multiple of two or more numbers, is that which contains those numbers a certain number of times; thus 36 is a common multiple of 4 and 9, being equal to 9 times the first, and 4 times the second.

*To find the least common Multiple of several Numbers.*—Reduce them all to their prime factors, then the product of the greatest powers of those prime factors is the least common multiple required. Let it be proposed to find the least common multiple of 12, 25, and 35, or the least number that will divide by each of them without a remainder.

Here $12 = 3 \times 2^2$; $25 = 5^2$, and $35 = 5 \times 7$;
therefore $3 \times 2^2 \times 5^2 \times 7 = 210$, the least common multiple required.

MULTIPLE Ratio, or *Proportion*, is that which is between multiples. If the less term of the ratio is an aliquot part of the greater, the ratio, or the greater to the less, is called the multiple, and that of the less to the greater, submultiple. A submultiple number is that contained in the multiple; thus, the numbers 1, 2, and 3, are submultiples of 9. Duple, triple, &c. ratios, as also sub-duples, sub-triples, &c. are so many species of multiple and submultiple ratios.

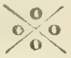
MULTIPLICAND, in Arithmetic, is one of the factors in multiplication, being that which is multiplied by the other, which is called the multiplier.

MULTIPLICATION, is one of the principal rules in arithmetic and algebra; and consists in finding the amount of a given number or quantity, called the multiplicand, when repeated a certain number of times expressed by the multiplier; and this amount is generally termed the product; also the multiplier and multiplicand are commonly called factors. Multiplication is either simple or compound.

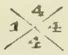
*Simple* Multiplication, is when the proposed quantities are integral numbers.—*Rule.* Place the multiplier under the multiplicand, so that units may fall under units, tens under tens, and so on. Then begin at the right hand, and multiply every figure in the multiplicand, by each of the figures in the multiplier. Find how many tens there are in the product of every two simple figures, and set down the remainder directly under the figure you are multiplying by, or, if there be nothing over, a cipher. Carry as many units as there were tens to the product of the next figure, and proceed in like manner till the whole is finished. Then add all the separate products together for the answer.

*Proof* of Multiplication. 1. Invert the operation, by making the multiplier and multiplicand change places, and if you thus obtain the same result, it is highly probable the work is right. 2. Cast out all the 9's from the multiplier, multiplicand, and product; and multiply the overplus of the two former together, and cast the 9's out of this product; then if this remainder be the same as that arising from the total product, the operation is probably right; but if not, it is certainly wrong. This proof depends upon a singular property of the number 9; *viz.* that any number divided by 9, will leave the same remainder, as the sum of its digits when divided by the same number. 3. Another proof for multiplication is drawn from a particular property of the number 11, which is this, that the sum of the digits in the odd places, that is, the 1st, 3d, 5th, &c. being taken from the sum of the digits in the 2d, 4th, &c. places, the remainder, when divided by 11, will leave the same overplus, as the whole number when divided by 11. If the former sum be greater than the latter, as many times 11 must be added to it, as will make the latter sum the greater of the two. This being observed, the proof by this number will be the same as in the former case.

*Example.*
45684 multiplicand.
4374 multiplier.
———————
209821816



proof by 9.



proof by 11.

But it must be evident that this process is at variance with all the known laws of mathematical science, since it supposes a knowledge of division even previous to that of multiplication, which is absurd; and the editor very reluctantly admits into the pages of his work an illustration which is opposed to practice, but sanctioned by the authority of a custom known only among the unscientific and illiterate.

The other proof by inverting the operation depends upon this; that the product of two numbers is the same, whichever of the two is the multiplier; or generally, that $a$ times $b$ is the same as $b$ times $a$; which, though generally considered as an axiom, is in fact a proposition, and one that is not very easily demonstrated.

*Compound* MULTIPLICATION, is the method of finding the product arising from a compound and simple quantity.—*Rule.* Place the multiplier under the lowest denomination of the multiplicand, and multiply this denomination by the multiplier. Find how many units of the next higher denomination are contained in the product; set down the remainder, and carry the units to the next product, with which proceed as before, and so on through all the denominations to the last, and the result will be the answer required.

*Note.* If the multiplier exceed 12, the operation will be much simplified as follows:—1. If the given multiplier be a composite number, multiply successively by each of its factors, instead of the whole number at once. 2. If the given multiplier be not a composite number, take that which is nearest to it, and multiply by its factors as before; then add or subtract as many times the first line, as the number so taken is less or greater than the multiplier. Also, if there be any fractional part belonging to the multiplier, take such part of the multiplicand as this fraction is of a unit, and add it to the result before found.

MULTIPLIER, or MULTIPLICATOR, the number by which another is multiplied.

MULTIPLYING GLASS, in Optics, one wherein objects appear increased in number. It is otherwise called a polyhedron, being ground into several planes that make angles with each other; through which the rays of light issuing from the same point undergo different refractions, so as to enter the eye from every surface in a different direction.

MULTIVALVES, in Natural History, the name of a general class of shell-fish consisting of three or more shells.

MUM, a kind of malt liquor much drunk in Germany, and chiefly brought from Brunswick, which is the place of most note for making it.

MUMMY, a body embalmed or dried, in the manner used by the ancient Egyptians: or the composition with which it is embalmed. Mummy has been esteemed resolvent and balsamic; but whatever virtues have been attributed to it, seem to be such as depend more upon the ingredients used in preparing the flesh than in the flesh itself.

MUNICIPAL, in the Roman civil law, an epithet which signifies invested with the rights and privileges of Roman citizens.

MUNICIPAL, in Great Britain, is applied to the laws that obtain in any particular city or province; and those are called municipal officers who are elected to defend the interest of cities, to maintain their rights and privileges, and to preserve order among the citizens.

MURAL ARCH, (from *murus*, a wall,) a wall, or arched wall, placed exactly in the plane of the meridian, for fixing a large quadrant, sextant, or other instrument, to observe the meridian altitude, &c. of the heavenly bodies.

MURÆNA, the *Eel*, a genus of fishes of the order apodes. There are five species, according to Shaw. Gmelin enumerates nine. The common eel is particularly distinguished by the steadiness and uniformity of its colours; an olive-brown on the back, and silvery lustre on the sides and beneath; but more expressively still by the great elongation of its under jaw. Its general size is from two to three feet; it is slow in its growth, and considered as very long lived. Its usual food consists of insects, worms, and the eggs of other fishes. It is viviparous, producing great numbers at a birth; but of a very diminutive size. It continues generally during the day in its hole in the banks, which it furnishes with two avenues, to facilitate its escape and security. By night it ranges for food. In winter it appears to be ingulfed in mud, and remains in this state of seclusion and tranquillity, if not torpor, till the return of spring invites it to a renewal of its excursions. The conger eel, generally darker above, and more splendid beneath than the former species, grows to its largest size in the Mediterranean, where it is sometimes found ten feet long, and a hundred pounds weight. It is found in the North American seas also: it occasionally, particularly in the spring, makes excursions into rivers, and is found in vast abundance in the Severn. Congers are extremely voracious, devouring immense quantities of the smaller fishes, and of crabs before the shell of the latter is completely formed and hardened.

MURDER. *See* HOMICIDE.

MUREX, in Natural History, a genus of univalve or simple shells, without any hinge, formed of a single piece, and beset with tubercles or spines. The mouth is large and oblong, and has an expanded lip, and the clavicle is rough.

MUREX, in Zoology, a genus of insects belonging to the order of vermes testacea. From a species of murex on the coasts of Guayaquil and Guatimala, in Peru, a liquor is extracted which dyes cottons, silks, and wool of a beautiful permanent purple colour. The shell which contains it adheres to the rocks that are washed by the sea. It is of the size of a large walnut. The liquor may be extracted two ways; some kill the animal after they have drawn it out of the shell, then press it with a knife from head to tail, separate from the body the part where the liquor is collected, and throw away the rest. When this operation, after being repeated on several snails, has afforded a certain quantity of fluid, the thread intended to be dyed is dipped in it, and the process is finished. The colour, which is at first of the whiteness of milk, becomes afterwards green, and is not purple till the thread is dry. Those who disapprove of this method draw the fish partly out of the shell, and, squeezing it, make it yield a fluid which serves for dyeing: they repeat this operation four times at different intervals, but always with less success. If they continue it, the fish dies. No colour at present known, says the Abbe Raynal, can be compared to this, either as to lustre, liveliness, or duration. It succeeds better on cotton than wool, linen, or silk.

MURIATES, in Chemistry, a genus of salts formed from the muriatic acid with certain bases.

MURIATIC ACID. When equal volumes of hydrogen and chlorine gases are mixed and exposed to light, they combine and produce a sour compound commonly called muriatic acid gas, or, in conformity to the modern nomenclature, hydrochloric acid gas. Muriatic acid may also readily be procured by acting upon common salt by sulphuric acid; the evolved gas must be received over mercury. It was first obtained pure by Dr. Priestley, but its composition was discovered by Scheele, and has since been most ably investigated by Sir Humphrey Davy. Muriatic acid gas extinguishes flame: it is greedily absorbed by water, which takes up 480 times its bulk, and has its specific gravity increased from 1 to 1·210. Thus, dissolved in water, it forms the liquid muriatic acid, or spirit of salt, and may easily be procured by distilling a mixture of dilute sulphuric acid and common salt, as directed in the London Pharmacopœia. The marine acid in commerce has a straw colour; but this is owing to accidental impurity; for it does not obtain in the acid produced by the impregnation of water with the aëriform acid. The muriatic acid is one of those longest known, and some of its compounds are among those salts with which we are most familiar. The muriates, when in a state of dryness, are actually chlorides, consisting of chlorine and the metal; but moisture makes them instantly pass to the state of muriates.

**MURRAIN**, or **Gargle**, a contagious disease among cattle, principally caused by a hot dry season, or general putrefaction of the air, which begets an inflammation of the blood, and a swelling in the throat, that soon proves mortal. The symptoms are, a hanging down and swelling of the head, abundance of gum in the eyes, rattling in the throat, a short breath, palpitation of the heart, staggering, a hot breath, and a shining tongue.

**MUS**, the *Rat*, a genus of mammalia, of the order glires. There are forty-six species. The musk rat, as large as a small rabbit, and very common in Canada, resembles the beaver in the shape of its body, and in its instincts and character. It lives in society, and constructs its habitation with great skill and art, about two feet in diameter, and stuccoed within with particular neatness, on the border of some lake or stream. On the outside it is covered with a matting of rushes, compacted with great closeness to preclude moisture. These animals live on roots and herbage, which, however, they do not store up in their houses, but make excursions for, as they are wanted during the winter; in summer they make long progresses in pairs. They have a strong odour of musk, and walk and run with great awkwardness; are easily tamed, and highly valued for their fur. The Norway rat, supposed to have been imported into Europe from India, has in this country almost extirpated the black rats. It subsists not only on grain and fruits, but frequently attacks poultry and rabbits, as well as various other animals. The black rat, is considerably smaller than the former; its habits are almost precisely similar. It is supposed to come from the same countries. It is reported by travellers, that in various parts of Germany it is sometimes taken and domesticated, and, having a bell put round its neck, is thus almost invariably found to alarm all others of its species from the vicinity. The water rat, inhabits the temperate and cold climates of Europe and Asia, frequenting the banks of rivers in which it burrows. It subsists on frogs, on roots and other vegetable substances; swims with great speed, and can remain under water a considerable time. It never infests houses. The hamster, is a species of the pouched rats, and the sole European species of that description. The pouches are one on each side of the mouth, and, when filled, are like two blown bladders. These animals are found in Poland and Russia, and are extremely injurious by the quantities of grain which they devour, and carry off for their autumnal store in their pouches. The females arrange their mansions differently from the males, and never reside with them. As winter approaches, they seclude themselves completely, and enjoy their stores, which are generally consumed when the winter reigns in full rigour: they roll themselves up, and continue till spring in a state of profound slumber. Their bodies are cold, the fat coagulated, and their limbs stiffened, and they may be opened without awaking them. The heart beats only fifteen times in a minute, while in the summer its pulsations are 150 in the same time. The waking of the hamsters from their lengthened sleep is gradual, occupying sometimes no less than two hours. These animals are unsocial, fierce, and malignant. They attack every weaker creature, and very frequently destroy each other. The common mouse, inhabits almost every part of the world, is shy and timid, but not ferocious. It produces generally from six to ten at a birth, and breeds several times in a year. Its skin is sleek, and its eyes are bright and lively; its limbs are neatly formed, and its movements are extremely agile. The long-tailed field-mouse, is somewhat larger than the former, and of a yellowish-brown colour. It feeds on acorns, fruits, and grain, and lays up magazines in its burrow for the winter. It is found principally in dry grounds, is common in all the temperate regions of Europe, and is particularly abundant and destructive in France, where it is stated to commit very great waste. Under a scarcity of the usual supplies, these animals are supposed to destroy each other. The harvest mouse, is the smallest of British quadrupeds, weighing only the sixth part of an ounce, Its nest is most artificially platted of the blades of wheat, and of the size of a cricket ball, the opening to it being closed up so skilfully, as to be almost imperceptible. Such is its compactness, that it may be rolled over the table without derangement. One found of this description contained eight young, and appeared completely full without the dam. In the winter these animals burrow deep in the earth; but their favourite habitation is the corn-stack. The blind rat, is perhaps one of the largest and most remarkable of its tribe, measuring between seven and eight inches in length, and being entirely destitute both of eyes and tail.

**MUSA**, in Botany, a genus of the polygamia monoecia class and order. Natural order of scitamineæ. There are three species: M. paradisiaca, plantain-tree, rises with a soft herbaceous stalk, fifteen or twenty feet in height; the lower part of the stock is frequently as large as a man's thigh, diminishing gradually to the top, where the leaves come out on every side, being often more than six feet long and two broad. When the plant is grown to its full height, the spike of flowers appears from the centre of the leaves nearly four feet in length, nodding on one side. The fruit is about nine inches long, and more than an inch in diameter, a little incurved, having three angles; the skin is tough, within is a soft pulp of a luscious sweet flavour; the spikes of the fruit are often so large as to weigh upwards of forty pounds. It is a native of the East Indies and other parts of the Asiatic continent; it is generally cultivated between the tropics, the fruit being excellent nutritious food. The banana-tree, differs from the preceding in having its stalks marked with dark purple stripes and spots: the fruit is shorter and rounder, with a soft pulp of a more luscious taste. *See* Banana.

**MUSCA**, in Natural History, the *Fly*, a genus of insects of the order diptera. This is a very numerous genus, not fewer than a thousand species having been enumerated. They are divided into sections; *viz.*, A. with short feelers; and B. without feelers. These sections are again separated into others. The larva in the different tribes of flies differ far more in habit than the complete insects, some being terrestrial, and others aquatic. Those of the common kinds are distinguished by the title of maggots, and spring from eggs deposited on various putrid substances. Several of the aquatic kinds are of singularly curious formation, and exhibit wonderful examples of the provision ordained by nature for the preservation of even the meanest animals. The general form of the pupa is that of an oval, differently modified, according to the species, and formed by the external skin of the larva. Some species cast their skin before they change into the pupa state.

**Musca Australis**, *the Southern Fly, or Bee*, is situated south of the Cross, and by the Antarctic circle; it contains four stars of the fourth magnitude. The introduction of the *Bee* among the celestial host is a pretty idea, as well on account of the natural qualities of this most extraordinary insect, as on account of its being the old hieroglyphic of royalty. Of the insentient part of animated nature, the bee is prince and chief for foresight, ingenuity, industry, and fidelity: it was thence the fittest symbol of a good king.

**Musca Borealis**, *the Northern Fly*, is a small and modern asterism, containing only six stars, *viz.* one of the third magnitude, two of the fourth, &c. It is situated north of Aries, and south of Triangula and Perseus.

**MUSCHENBROEK**, **Peter**, a very eminent mathematician and philosopher, was born at Utrecht, about the year 1700. He was professor of mathematics, first in that city, and afterwards at Leyden, where he died in 1761.

**MUSCI**, in Botany, *Mosses*, one of the seven families into which Linnæus divided all vegetables. These plants constitute the second order of the class cryptogamia. This order is subdivided into eleven genera, from the presence or absence of the calyx, which in these plants is a veil that is placed over the tops of the stamina, and denominated calyptra, from the sexes of the plants, which bear male and female flowers, sometimes on the same, sometimes on distinct roots, and from the manner of growth of the female flowers, which are sometimes produced singly, sometimes in bunches or cones.

Musci, is also the name of the fifty-sixth order in Linnæus's Fragments of a Natural Method, consisting of genera which are exactly those of the second order in the class cryptogamia. These plants resemble the pines and firs, and other evergreens in that class, in the form and disposition of their leaves, and manner and growth of the female flowers, which are generally formed into a cone. They frequently creep, and extend themselves like a carpet upon the ground, trees, and stones, collected into bunches or tufts. Few of the mosses are annual plants, being mostly perennial and evergreens. Their growth is slow; though preserved dry several years, they resume their original verdure upon being moistened. They delight in a cool moist situation, and northerly exposure, where they are screened from the sun. The roots are fibrous, slender, branched, and short. The stems and branches are cylindric and weak, creeping on the ground, and striking root on every side.

MUSCICAPA, the *Fly-catcher*, a genus of birds of the order passeres. There are seventy-nine species. The spotted fly-catcher arrives in this country in the spring, and leaves it in September. It attaches its nest not unfrequently to the end of a beam of a house; and sometimes builds it in a vine or sweet-briar tree, spread against a wall. It returns for a succession of seasons to the same situation. It feeds on insects, which it catches with astonishing dexterity, sometimes on the wing, sometimes by a sudden leap from its perch. It is one of the most silent and most familiar of summer birds. Its only note is a plaintive sound on the approach of danger. In Kent it is called the cherry-sucker, being particularly fond of that fruit. The pied fly-catcher, is not to be found in great numbers in any part of this island, but is most frequently to be met with in Yorkshire, and the contiguous counties.

MUSCLE, in Anatomy, a part of the human body, destined to move some other part, in general by a voluntary motion, being composed principally of flesh and tendinous fibres, with veins, nerves, and lymphatics; surrounded by, or enclosed in, one common membrane. The muscular parts of animals are known in common language by the name of flesh. Muscular flesh is composed of a great number of fibres and threads, of reddish or whitish colour; these, after they have been acted on by water, to separate the extraneous matter, are left in the state of gray fibres, insoluble in water, and becoming brittle when dry. The muscles likewise contain albumen, gelatine, extractive, phosphate of soda, of ammonia, and lime.

MUSCLES, *Insertion and Force of the.* The all-wise Author of nature has furnished animals with limbs moveable about the joints by means of muscular cords inserted near the joint, or centre of motion. In order to calculate the force of any muscle, we are to consider the bones as levers; and then the power or force of the muscle will be always to the resistance or weight it is capable of raising, as the greater distance of the weight from the centre of motion is to the lesser distance of the power. The muscles that move the lower jaw, when taken altogether, do not in a man exceed the weight of one pound, and yet exert a force equal to 534 pounds, and in mastiff-dogs, wolves, bears, lions, &c. their force is vastly superior. The motion of the far greater part of the muscles are voluntary, or dependent on our will; those of a few others involuntary. The former are called animal, the other natural motions. Finally, the motions of some of the muscles are of a mixed kind, partly animal and partly natural. Those muscles which perform the voluntary motions, receive nerves from the brain or spinal marrow; those which perform their motions involuntarily, have their nerves from the cerebellum; and those whose motion is partly voluntary, and partly involuntary, have theirs in part from the brain, and in part from the cerebellum.

MUSES, certain fabulous divinities amongst the Pagans, supposed to preside over the arts and sciences. Some reckon the muses to be no more than three, *viz.*, Mneme, Aoede; and Melete; that is, Memory, Singing, and Meditation: but the most ancient authors, and particularly Homer and Hesiod, reckon nine; *viz.*, Clio, which means glory; Euterpe, pleasing; Thalia, flourishing; Melpomene, attracting; Terpsichore, rejoicing the heart; Erato, the amiable; Polyhymnia, a multitude of songs; Urania, the heavenly; and Calliope, sweetness of voice. To Clio they attributed the invention of history; to Melpomene, tragedy; to Thalia, comedy; to Euterpe, the use of the flute; to Terpsichore, the harp; and to Erato, the lyre and lute; to Calliope, heroic verse; to Urania, astrology; and to Polyhymnia, rhetoric.

MUSEUM, a collection of rare and interesting objects, selected from the whole circle of natural history and the arts, and deposited in apartments or buildings, either by the commendable generosity of rich individuals, generally governments or monarchs, for the inspection of the learned and the great mass of the public. The term, which means literally, a study, or place of retirement, is said to have been applied originally to that part of the royal palace at Alexandria appropriated for the use of learned men, and the reception of the literary works then extant. According to ancient writers, they were formed into classes or colleges, each of which had a competent sum assigned for their support; and we are further informed, that the establishment was founded by Ptolemy Philadelphus, who added a most extensive library.

MUSHROOM. *Agaricus Campestris.*—Is cultivated and well known at our tables for its fine taste and utility in sauces. These plants do not produce seeds that can be saved; they are therefore cultivated by collecting the spawn, which is found in old hot-beds and in meadow lands. Various methods have been lately devised for raising mushrooms artificially: but none seem to be equal to those raised in beds, as is described in all our books of gardening. Raising this vegetable in close rooms by fire heat, has been found to produce them with a bad flavour; and they are not considered so wholesome as those grown in the open air, or when that element is admitted at times freely to the beds.

Mushroom, *Brown. Agaricus Cinnamomeus.*—The whole of this plant has a nice smell, and when stewed or broiled has a pleasant flavour. It is to be found in dry woods, old pastures, &c. and is fit for use in October.

Mushroom, *Violet. Agaricus Violaceus.*—This mushroom requires more broiling than all the rest; but when done well and seasoned, it is very good. It is found in dry woods, old pastures, &c. where it grows to a large size.

MUSIC, a science, which teaches the properties, dependencies, and relations of melodious sounds; or the art of producing harmony and melody by the due combination and arrangement of those sounds. The ancient writers on this science differ greatly as to its object and extent. In general they give to it a much wider latitude than that which it obtains with us. Under the name of music they comprehended not only the melodious union of voices and instruments, but also the dance, gesture, poetry, and even all the other sciences. Hermes defines music to be the general knowledge of order; which was also the doctrine of Plato, who taught that every thing in the universe was music. Music, however, properly so called, only concerns the due order and proportion of sounds; and is divided into two parts, the theoretical and the practical. Theoretical music comprehends the knowledge of harmony and modulation; and the laws of that successive arrangement of sound by which air or melody is produced. Practical music is the art of bringing this knowledge and those laws into operation, by actually disposing of the sounds, both in combination and succession, so as to produce the desired effect; and this is the art of composition: but practical music may in fact be said to extend still further, and to include not only the production of melodious and harmonious composition, but also its performance.

MUSICAL or Harmonial Proportion. *See* Proportion.

MUSK, a substance secreted into a bag, situated in the umbilical region of the moschus moschifer. Its colour is brownish red; its feel unctuous; its taste bitter; and its smell aromatic and intensely strong. It is partially soluble in water, which acquires its smell; and in alcohol, but that liquid does not retain the odour of musk.

MUSKET, a fire-arm, borne on the shoulder, and used in war. The length of a musket is fixed at three feet eight inches from the muzzle to the pan. In Fortification, the length of the line of defence is limited by the ordinary distance of a musket-shot, which is about one hundred and twenty fathoms.

MUSKETOON, a short thick musket, whose bore is the thirty-eighth part of its length: it carries five ounces of iron, or seven and a half of lead, with an equal quantity of powder.

**MUSLIN**, a fine thin sort of cotton cloth, which bears a downy nap on its surface. *See* COTTON.

**MUSTARD**, WHITE. *Sinapis Alba.*—This is sown early in the spring, to be eaten as salad with cress and other things of the like nature; it is of easy culture. A salad of this kind may be readily raised on a piece of thick woollen cloth, if the seeds are strewed thereon and kept damp; a convenient mode practised at sea on long voyages. Cress and rape may be raised in the same manner.

**MUSTELA**, a genus of quadrupeds of the order feræ. There are twenty-eight species. M. lutra, the common otter, found in almost every part of Europe, as well as in the colder regions of Asia; inhabiting the banks of rivers, and feeding principally on fish. The length of the otter is nearly two feet from nose to tail, and of the tail about 16 inches. Its colour is a deep brown, with a small light-coloured patch on each side of the nose, and another under the chin. The otter shews great sagacity in forming its habitation; it burrows under ground on the bank of some river or lake, and always makes the entrance of its hole under water, working upwards to the surface of the earth; and, before it reaches the top, makes several holts or lodges, that in case of high floods it may have a retreat, and then makes a minute orifice for the admission of air. The otter is naturally a very fierce animal, and will inflict very severe wounds on its antagonists. The female produces four or five young at a birth; this commonly happens early in the spring. Young otters, if taken at a very early age, may be tamed and taught to hunt for fish, and bring them to their master. The smaller otter, very much resembles the common otter, but is smaller: the body is of a dusky colour, but with a considerable cast of tawny. In size it falls short of the common otter, measuring about a foot in length. Its fur is very valuable, and next in beauty to that of the sable. The sea otter, is the largest of the otters, measuring about three feet from the nose to the tail, and the tail thirteen inches. The colour of this species is a deep glossy brownish black, the fur being extremely soft and very fine. Great numbers are found in Behring's islands, the Kamschatka, the Aleutian, Fox, and Kurile islands. The ferret, has eyes red and fiery. It inhabits Africa. In Europe it is tamed to catch rabbits, rats, &c. It procreates twice a year, and brings forth from six to eight at a time. The stoat, is about ten inches long, hair short, which in northern climates becomes white, except the outer half of the tail, which remains black. The fur is very valuable.

**MUSTER**, in a military sense, a review of troops under arms, to see if they be complete, and in good order; to take an account of their numbers, the condition they are in, viewing their arms and accoutrements, &c.

MUSTER *Roll*, a specific list of the officers and men in every regiment, troop, or company, which is delivered to the inspecting field-officer, muster-master, regimental or district paymaster (as the case may be) whereby they are paid, and their condition is known.

**MUSTERING**, the act of calling over a list of the whole ship's company, or any particular detachment thereof, who are accordingly to answer to their names.

**MUTE**, a person refusing to plead to an indictment for felony, &c. is considered as pleading guilty, and punished as upon confession. A prisoner deaf and dumb from his birth may be arraigned for a capital offence, if intelligence can be conveyed to him by signs or symbols.

MUTE, in Grammar, a letter which yields no sound without the addition of a vowel.

**MUTILLA**, genus of insects of the order hymenoptera.

**MUTINEER**, one who mutinies.

**MUTINY**, in a military sense, to mutiny is to rise against authority. Any officer or soldier who shall use traitorous or disrespectful words against the king, or any of the royal family; or who shall behave himself with contempt or disrepect towards the general, or other commander-in-chief of the forces, or shall speak words tending to their hurt or dishonour; or who shall begin, excite, cause, or join in any sedition; or who, being present at any mutiny or sedition, does not use his utmost endeavours to suppress the same, or, coming to the knowledge of any mutiny, or intended mutiny, does not give information to his commanding officer; or who shall strike his superior officer, or draw, or offer to draw, or lift up any weapon or offer any violence against him, being in the execution of his office; or who shall disobey any lawful command of his superior officer, is guilty of mutiny.

**MUTULE**, in Architecture, a kind of square modillion, set under the corniche of the Doric order.

**MYA**, a genus of insects of the vermes testacea class and order. There are about twenty-five species. M. declivis has a brittle semi-transparent shell, sloping downwards near the open end; the hinge slightly prominent. It is found about the Hebrides, where the fish is in great esteem. M. margaritifera, is found in mountainous rivers, and about cataracts. It is about five inches long, and half as many broad; and it is noted for producing mother-of-pearl and pearls; the latter is said to be a disease of the fish analogous to the stone in the human body.

**MYAGRUM**, *Gold of Pleasure*, a genus of the tetradynamia siliculosa class and order. There are ten species. The sativum is cultivated in Germany for the sake of the expressed oil of the seeds.

**MYCTERIA**, the *Jabira*, a genus of birds of the order grallæ. The American jabira is nearly six feet in length. It abounds in the levels of Cayenne, and other parts of South America, feeds upon fish, of which it devours immense quantities, and builds in vast trees, laying only two eggs. It is extremely wild, and when young is used for food. M. Asiatica is likewise a very large bird, inhabits the East Indies, and feeds on snails.

**MYOPES.** Those who by a natural defect have the cornea and crystalline humour too convex, are called myopes. This figure, increasing the quantity of refraction, tends to render the rays of such pencils as are formed in the eye more convergent, so that the point where these same rays meet is on this side of the retina. Myopes see distinctly those objects only which are near, which send towards the eye rays more divergent, and thereby less disposed to converge, through the effect of refraction in the crystalline and other humours. This imperfection is remedied by the use of a glass slightly concave.

**MYOXUS**, the *Dormouse*, in Natural History, a genus of mammalia, of the order of glires, four grinders in each jaw; long whiskers, tail cylindric, bristly, and thicker towards the end; legs of equal length; fore feet with four toes. These animals feed only on vegetables, and burrow in the ground, in which they continue during the winter in a torpid state. They are nocturnal, sleeping in their habitations the greater part of the day; they carry food to their mouths with their fore paws, sitting erect; and advance by leaps of several feet at a time, instead of walking. There are four species. The fat dormouse, found in Germany and Russia, has much of the manners of a squirrel, haunting trees, and feeding on fruits and nuts, which it stores for its winter consumption. It was highly valued by the Romans as an article of food. It is six inches long to the tail, which is about four: it is not easily tamed. The common dormouse, nearly of the size of a mouse, and inhabits thick hedges, making its nest in the hollow of some tree, forms a hoard for the winter, during which it is for the greater part abstinent and torpid. It is occasionally roused by the intervention of temperate days, recurs to its stock, and then returns to its slumbers, till spring recovers it to daily exertion.

**MYRIAD**, the number ten thousand.

**MYRISTICA**, *Nutmeg Tree*, a genus of the dioecia syngenesia class and order. Natural order of lauri. There are three species, of which M. aromatica, aromatic or true nutmeg tree, grows to a considerable size in the East Indies. The leaves are aromatic; and if the trunk or branches be wounded, they will yield a glutinous red liquor.

**MYRMECOPHAGA**, the *Ant Eater*, a genus of mammalia, of the order bruta. They subsist on insects; thrusting their tongue into a nest of ants, the glutinous substance which exudes from it serves to attach to it inextricably numbers of them, and when the animal perceives that he has secured a sufficient number, he retracts his tongue, and swallows his victims. There are seven species.

**MYRMELEON**, *Lion Ant*, a genus of insects of the order neuroptera. There are 16 species. The Myrmeleon in the larva state preys on ants and lesser insects; and for the purpose of ensnaring them sinks itself into the sand, and forms a kind of funnel or pit in which it lies buried. the head only appearing above the sand.

MYROXYLUM, a genus of the monogynia order, in the decandria class of plants. There is but one species, the peruiferum, a native of Peru, and the warmer parts of Africa. It is this shrub that yields the balsam of Peru, which is said to be extracted from it by coction in water. This balsam, as brought to us, is nearly of the consistence of thin honey, of a reddish-brown colour inclining to black, and an agreeable aromatic flavour.

MYRRH, a gum resin brought from the Levant and East Indies, and used in medicine. It is hard, dry, glossy, of a reddish brown colour, with an admixture of yellow: transparent or opaque; of a peculiar strong smell, and a bitter, somewhat biting taste. With water it forms a yellow opaque soluber, and by distillation yields an essential oil.

MYRTUS, *Myrtle*, a genus of the icosandria monogynia class and order. Nat. ord. hesperideæ. There are thirty-six species, and many varieties. This genus is composed of small trees and shrubs; flowers in some solitary, with two scales at the base; in others, forming opposite corymbs or panicles, axillary or terminating. The common myrtle is a native of Asia, Africa, and the south of Europe. The allspice tree is about thirty feet in height, and two in circumference. It is a native of New Spain and the West Indies. The flavour and fruit have a highly aromatic fragrance.

MYTHOLOGY, the history of the fabulous gods and heroes of antiquity, with the explanations of the mysteries or allegories couched therein.

MYTILUS, the *Mussel*, a genus of insects of the vermes testacea class and order. There are between fifty and sixty species. M. margaritiferus, which inhabits the American and Indian seas, is about eight inches long, and something broader; the inside is beautifully polished, and produces true mother-of-pearl, and frequently the most valuable pearls. M. edulis inhabits European and Indian seas, found in large beds, adhering to the other bodies by means of a long silky beard: the fish affords a rich food, but is often noxious to the constitution.

MYXINE, the *Hag*, a genus of insects belonging to the order of vermes intestina.

# N.

NABOB is a title in the East Indies, which in its origin signified deputy, and was first assumed by subordinate governors, who ruled over districts under the soubah, or governor of a province. In the declension of the power of the Mogul, many of the nabobs obtained independent authority.

NACRE, or MOTHER OF PEARL, is the inner part of the shell of the pearl muscle. This is of a brilliant and beautifully white colour, and is usually separated from the external part by aqua-fortis, or the lapidary's mill. Pearl muscle shells are on this account an important article of traffic with China and many parts of India, as well as to the different countries of Europe. They are manufactured into beads, snuff-boxes, buttons, and spoons, fish and counters for card players, and innumerable other articles. The pearl muscles are not considered good as food; though after having been dried in the sun, they are sometimes eaten by the lower classes of people in the countries near which they are found.

NAILS, in Building, are small spikes of iron, brass, &c. for fastening pieces of wood together. Among the Hebrews, nails were anciently used for cancelling bonds, by striking them through the writing. The several sorts of nails are very numerous; as, 1. Back and bottom nails, with flat shanks to hold fast and not open the wood. 2. Clamp-nails for fastening the clamps in building, &c. 3 Clasp-nails, whose head clasping and sticking into the wood, render the work smooth, so as to admit a plane over it. 4. Clench-nails, used by boat and barge builders. 5. Clout-nails, used for nailing on clouts to axletrees. 6. Deck-nails. 7. Dog-nails, for fastening hinges on doors, &c. 8. Flat-points, much used in shipping, and are proper where there is occasion to draw and hold fast, and no conveniency of clenching. 3. Jobent-nails, for nailing thin plates of iron to wood, &c. 10. Lead-nails, for nailing lead, leather, and canvass to hard wood. 11. Port-nails, for nailing hinges to the ports of ships. 12. Pound-nails, which are four square, used for paling. 13. Ribbing-nails, principally used in ship building, for fastening the ribs of ships in their places. 14. Rose-nails, which are drawn four square in the shank, and commonly in a round tool. 15. Rother-nails, which have a full head, and are chiefly used in fastening rother irons to ships. 16. Round-head nails, for fastening on hinges, or for any other use where a neat head is required. 17. Scupper-nails, which have a broad head, and are used for fastening leather and canvass to wood. 18. Sharp nails, with sharp points and flat shanks, for nailing soft wood. 19. Sheathing-nails. 20. Square-nails, used for hard wood, and nailing up wall-fruit. 21. Tacks, &c. Nails are said to be toughened when too brittle, by heating them in a fire shovel, and putting some tallow or grease among them.

The following table exhibits Mr. Bevair's experiments on the adhesion of nails when driven into dry Christiana deal, at right angles to the grain of the wood.

| | Number of lbs. Avoirdupois. | Inches long. | Inches forced into the wood. | Pounds required to extract. |
|---|---|---|---|---|
| Fine sprigs, | 4,560 | 0·44 | 0·40 | 22 |
| Ditto, | 3,200 | 0·53 | 0·44 | 37 |
| Threepenny brads, | 618 | 1·25 | 0·50 | 58 |
| Castiorn nails, | 380 | 1·00 | 0·50 | 72 |
| Sixpenny nails, | 73 | 2·50 | 1·00 | 187 |
| Ditto, | — | — | 1·50 | 327 |
| Ditto, | — | — | 2·00 | 530 |
| Fivepenny nails, | 139 | 2·00 | 1·50 | 520 |

The percussive force required to drive the common sixpenny nails to the depth of 1½ inch into dry Christiana deal with an iron weight of about 6¼ lbs. was four blows falling freely the space of twelve inches, and the steady pressure required to produce the same effect was 400 lbs.

A sixpenny nail driven one inch across the grain into dry elm required 327 lbs. to extract it; driven endways, or longitudinally, it required 257 lbs. for its extraction: driven endways two inches into Christiana deal, it was drawn out by a force of 257 lbs.; but driven in one inch only in the same direction, it was extracted by 87 lbs. The relative adhesion, therefore, when driven transversely or longitudinally, is as 100 to 78, or about 4 to 3, in dry elm; and as 100 to 46, or as 2 to 1 in deal.

To extract a common sixpenny nail from a depth of one inch out of dry oak, required .................... 507 lbs.
Dry beech, ........................ 667 lbs.
Green sycamore, .................. 312 lbs.

A common screw of 1-5th of an inch diameter was found to have an adhesion about three times that of a sixpenny nail. The resistance to the entrance of a nail was found to be to that of extraction, in some experiments, as 6 to 5.

Nail is also a measure of length, being the sixteenth part of a yard.

NAPHA, a name given by many of the writers in pharmacy to orange-flower water.

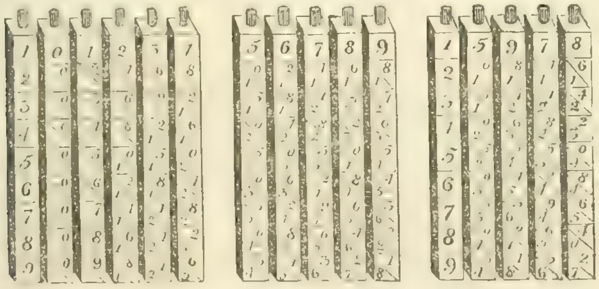
NAPHTHA, is a native combustible liquid, which differs from petroleum, which is obtained by the distillation of coals, in being purer and lighter. It is found abundantly near the Caspian sea, and in some places in Italy and Sicily, and is burnt as oil.

Naphtha, or Rock Oil, is a yellow or brownish bituminous fluid, of strong penetrating odour, somewhat greasy to the touch, and so light as to float even on spirit of wine. By exposure to the air, the consistence of naphtha is increased, and it passes into petroleum. There are copious springs of naphtha at Baku, on the shore of the Caspian sea; and also in some parts of Italy, particularly at Monte Ciaro, near Riacenza. At Pitchford, in Shropshire, extensive strata or beds of sandstone are saturated with this mineral fluid, which is obtained from the stone by distillation, and is sold as a remedy against sprains and rheumatism, under the name of *Betton's British Oil.* By the Persians and Russians naphtha is used internally as a cordial. On the shores of the Caspian it is burnt in lamps instead of oil; and in some countries it is used in the composition of varnish, for the purpose of rendering it more shining. It is the property of naphtha to burn with great readiness, and a white flame, leaving little residuum.

NAPIER, John, Baron of Merchiston, in Scotland, was an excellent mathematician, and the inventor of logarithms, in the sixteenth century.

It is not, however, on this invention only that his fame is established; for he also made considerable improvements in spherical trigonometry, &c. particularly by his catholic or universal rule, being a general theorem by which he resolves all the cases of right-angled spherical triangles in a manner very simple and easy to be remembered, namely, by what he calls the five circular parts. *See* Circular Parts. His construction of logarithms too, beside the labour of them, manifests the greatest ingenuity. Kepler dedicated his Ephemerides to Napier, which were published in the year 1617; and it appears from many passages in his letter about this time, that he accounted Napier to be the greatest of this age in the particular department to which he applied his abilities.

Napier's *Rods* or *Bones*, (as in the following figure) a method contrived by Lord Napier, for the more easy performing of the arithmetical operations of multiplication, division, &c. These rods are five in number, made of bone, ivory, horn, wood, or pasteboard, &c. Their faces are divided into nine little squares, each of which is parted into two triangles by diagonals. In these little squares are written the numbers of the multiplication table; in such manner as that the units or right-hand figures are found in the right-hand triangle; and the tens, or left-hand figures, in the left-hand triangle. To multiply numbers by Napier's bones, dispose the rods in such manner, as that the top figures may exhibit the multiplicand, and to those on the left hand join the rod of units: in which seek the right-hand figure of the multiplier; and the numbers corresponding to it, in the squares of the other rods, write out, by adding the several numbers occurring in the same rhomb together and their sums. After the same manner write out the numbers corresponding to the other figures of the multiplier, disposing them under one another as in the common multiplication; and lastly, add the several numbers into one sum.



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   5978
    937
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  41846
 17934
53802
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5601386
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For example, suppose the multiplicand 5978, and the multiplier 937. From the outermost triangle on the right-hand figure, which corresponds to the right-hand figure of the multiplier 7, write out the figure 6, placing it under the line. In the next rhomb toward the left, add 9 and 5; their sum being 14, write the right-hand figures 4 against 6; carrying the left-hand figure 1 to 4 and 3, which are in the next rhomb: join the sum 8 to 46 already set down. After the same manner, in the last rhomb, add 6 and 5, and the latter figure of the sum 11, set down as before, and carry 1 to the three found in the left-hand triangle; the sum 4 join as before on the left-hand, 1846. Thus you will have 41846 for the product of 5978 by 7. And in the same manner are to be found the products for the other figures of the multiplier; after which the whole is added together as usual.

NARCISSUS Poeticus, or Pseudo Narcissus. These are much cultivated in gardens for the sake of the flowers. The florists have by culture made several varieties, as double blossoms, which are great ornaments. The season for planting the bulbs of Narcissus of all kinds is the month of October: they will grow well in any soil, and thrive best under the shade of trees.

NARCOTICS, in Medicine, are soporiferous drugs, which bring on a stupefaction; as the poppy or opium; and those prepared from mandragoras, hyoscyamus, stramonium, and datura.

NARDUS, a genus of plants belonging to the triandria class, and in the natural method ranking under the fourth order, Gramina. Both as a medicine and luxury, this plant was highly valued by the ancients. Among the Romans, this ointment of nard was used at baths and feasts as a favourite perfume. Its value is evident from that passage of scripture, which informs us that our Saviour's head was anointed with a box of it, with which Judas found fault.

NARWAL, or The Sea Unicorn, is a marine animal from twenty to thirty feet in length, with a long, tapering, twisted, and pointed weapon of ivory in front of the head. It has a small fin on each side of the breast; in place of fore feet, an horizontally flattened tail, and a spiracle or breathing-hole on the highest part of the head. The skin is white, variegated with numerous black spots on the upper part of the body; and the weapon is generally from five to eight feet in length. These animals are found in the Greenland seas, and they occasionally migrate southward of the British coasts. Their name of *narkwal* signifies a whale that subsists on dead bodies. The Greenlanders pursue the narwals as they do other whales, chiefly on account of the oil which they obtain from them. This is considered in many respects superior to the oil of the great whale, and is used by them both with food, and to burn in their lamps. These people also eat the flesh of the narwal.

NATRON, native carbonate of soda. It is found in vast abundance in the lakes near Alexandria in Egypt. The existence of natron in the midst of plains, in the waters of marshes and lakes which cover them, is one of the most interesting facts in geology. We find this phenomenon every where in the midst of vast deserts, which occur in so many places of our globe. From all that we know of this mineral production in Egypt, Arabia, Persia, India, Thibet, China, Siberia, the plains near the Caspian and Black Seas, in Asia Minor, in Hungary, and at Mexico, we have reason to believe that it occurs in the same circumstances and with the same relation. It is found every where in the midst of sands, mixed with clay and marl, and accompanied with other salts, of which common salt is the most constant. In warm weather the natron is constantly efflorescing at the surface of the soil. The origin of this natron cannot with certainty be determined. The opinion which will most naturally present itself is, that natron occurs already formed in the sand or clay at a certain depth, along with the different salts with which it is mixed, and that the waters, by filtering through the mass of earth, in order to regain their level, laid hold of those substances, which they carried to the surface of the soil. This opinion, however, cannot be supported by any positive observation, because no pits have been dug which confirm it, in the different places where natron appears at the surface. So also, no where in the deposits of rock salt is carbonate of soda found; and the waters of the sea are equally destitute of it. Nevertheless, on the sea-shore natron is formed, though in a small quantity, efflorescing at the surface; and here its origin must be attributed to the decomposition of the muriate of soda. This decomposition may be effected in various ways, and advantage is taken of this in the manufacture of artificial subcarbonate of soda, in which several methods, more or less perfect, have been successfully employed. It is probable, therefore, that it is from the natural decomposition of muriate of soda that natron is formed. The natron in Egypt, in the opinion of Mr. Berthollet, is produced by the reciprocal action of muriate of soda and carbonate of lime, assisted by efflorescence. The lakes of Egypt contain a great quantity of muriate of soda, and they occur in the midst of a calcareous formation, the rocks of which project here and there through the sand which covers them. Masses or beds of gypsum also occur, which probably accompany the deposits of rock salt which the waters traverse before arriving at the lakes. The same explanation will probably be found to be applicable to many other instances of the formation of natron, or mineral carbonate of soda.

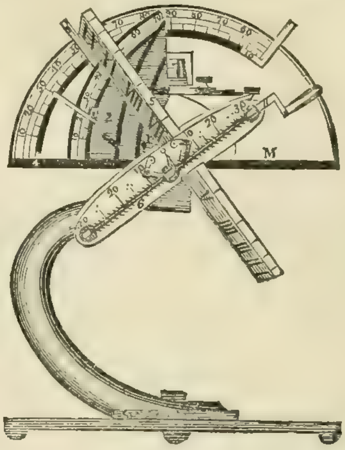
NATURAL DAY, is the time the sun takes in passing from the meridian of any place, till it comes round to the same meridian again; but the natural days are not equal to one another; and *equation* of time, is the difference between the mean length of the natural day, (or 24 hours) and the length of any single day measured by the sun's motion, or between *mean time* and *apparent time*. For any natural day is the time in which the earth performs one revolution round its axis, and such a portion of the second as is equal to the sun's increment of right ascension for that day; but the sun's daily increments of right ascension are unequal, therefore the additional portion of the second revolution will sometimes be greater and sometimes less, and consequently, the times in which the natural days are completed will be unequal. If the sun were to move uniformly round the equator in the same time in which it appears to describe the ecliptic, its apparent daily motion would be a measure of mean time: for the natural days in that case being liable to no variation, either from the inclination of the sun's orbit, or the irregularity of its motion, must be equal.

NATURAL HISTORY, may be divided into two heads; the first teaches us the characteristic or distinctive marks of each individual object, whether animal, vegetable, or mineral: the second makes us acquainted with all its peculiarities, as to its habits, its qualities, and its uses.

NAUSEA, or SICKNESS, arises generally from something which irritates the stomach.

NAUTICAL INDICATOR, *for finding the Latitude, Longitude, and Variation, invented by James Hunter, member of the Glasgow Philosophical Society.*—The indicator consists of a stand supporting a circular plate of polished brass, about 14 inches in diameter, representing the horizon, and marked and numbered accordingly with the proper divisions. This horizon is surmounted by a semicircular plate, as a meridian, set at right angles to the plane of the horizontal plate, properly divided and furnished, with an index attached to a nonius indicating minutes. This meridian plate is cut out at the centre to allow room for a pivot, or hinge, for other parts of the indicator. On one side of this meridian are placed two quadrants, and on the other side one, similarly divided as the meridian, and furnished with a similar index and nonius. These quadrants are moveable on a pivot, or hinge, rising perpendicular from the centre of the horizontal plate; or, agreeing to this centre, they are singly moveable on the pivot, but capable of being attached at any relative distance, and retained in that situation by a screw, binding together tails attached for the purpose. To the east and west points of the horizontal plate is attached a horary circle, divided into hours, &c. This horary circle represents the daily path of the sun, and it may be furnished with a nonius, as other parts are. This circle is so attached to the horizontal plate, that it can be moved parallel to it, to suit the sun's declination; this is effected by the circle being attached to two tangent plates, which by grooves slide on the projections from the horizontal plate by means of screws passing through and working in these projections, and carrying the tangent plates, and with them the horary circle, to the degree of the sun's declination. This degree is indicated on a scale of tangent divisions on the tangent plates, and as such tangents are of various lengths, an expanding *vernier* is used to adjust them. Its expansion is effected by friction wheels and springs working against a proper curve.

*Elevation of Hunter's Nautical Indicator.*

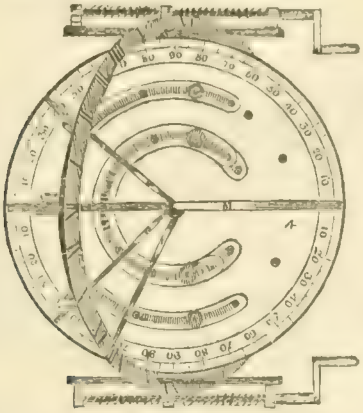


*References to the Figures.*—1, 2, 3, the quadrants of altitude, and also arches of azimuth circles; 4 is the apparent horizon, on which the azimuths and amplitudes are given; 5, the horary circle, on which the hours and minutes of time are given; 6, the scale of declination, with an expanding vernier; 7, 8, 9, sliding indexes, with their respective thumb screws; 10, a sliding stop; 11, continual screws for setting the indexes of declination; S, the support, on which the instrument turns; M, the meridian.—*Note.* The same references agree both to the plan and elevation.

*Use of the Indicator.*—Its use is to discover the latitude, longitude, and variation of the compass, without a meridian observation; or to find the whole path of the sun and the ship's place, by having ascertained a small portion of his path. Thus the indicator will frequently supersede the necessity of calculations—will prove their accuracy—or correct their inaccuracies, and enable an ordinary seaman to supply the place of captain or mate, in case of necessity. It will be of the most important utility in case of inconstant, stormy weather, when observations of the meridian altitude of the sun are unattainable.

*Manner of using the Indicator.*—1st. By the side screws and scales, the horary circle is to be so adjusted to the declination of the day of the month, as marked in the tables of declination. 2d. An observation of the sun by Hadley's or other quadrant, is to be taken, and the moveable quadrant for that from the meridian, adjusted by its index to the observation. Also, an hour, or any practical time after, another observation is to be taken and noted on the other moveable quadrant in the same manner, noting the time elapsed between the observation by any well-going watch, and then connecting both to move together. Then the indices of the two quadrants are to be applied to the scale on the edge of the horary circle, at the distance noted by the intervening time, and at such part of the circle, that both indices will accurately touch its edge. In this contact each index will indicate the true time of the observation. The index on the meridian, brought into contact with the horary circle, will give at the same time the sun's true meridian altitude, and the latitude of the ship's place. The place of the quadrant on the horizontal plate, will give the true bearing of the sun at the time of observation. The true time of observation at the ship is to be compared by the chronometer with the time at the radical meridian, and the difference reduced into degrees and minutes, gives the longitude—the difference between the true bearing of the sun, found as above, and the bearing given by the compass, is equal to the variation at the place of observation, and the index on the meridian gives the *latitude*. Thus the decision, or ascertaining of the three great points, is facilitated, and nearly reduced to inspection, *viz.* latitude, longitude, and variation. If the one observation is taken A. M. and the other P. M. the moveable quadrant on each side is used. If both observations are obtained P. M. the quadrant nearest the meridian is first used.

*Plan of Hunter's Nautical Indicator.*



In the year 1817 Mr. Hunter exhibited his invention in Glasgow; in November, 1823, there appeared in the London Magazine the following notice of an instrument for finding the Latitude at once, without the help of Logarithms or Calculations, from two observations, taken at any time of the day:—The inventor of this instrument, Joseph Bordwine, Esq. professor of fortification at the East India Company's Military College at Addiscombe, took out a patent for his discovery, and the Court of Directors issued orders that this instrument be henceforth used throughout the whole of their naval department. Mr. Bordwine's nautical instrument is intended to put within the reach of every commander of a vessel, the solution of that important problem in navigation, *viz.* the determination of the latitude by two observations of the sun, or other celestial body, taken at any period of the day, a problem which has engaged the attention of scientific men for a long time past, with the view of rendering the forms of calculation more simple than by the old method. The instrument does away with calculation altogether, giving the results in itself. It is formed of four circular arcs, (the greatest about nine inches in diameter,) having a common centre, and traversing about each other. On two of these are scales for the declination of the object observed, and on the other two scales for the altitudes which are taken for the usual instruments, quadrant, &c. There is also a fourth semicircle, fixed in position, for the time elapsed between the observations. In working it, the declination for the day is set off, the time adjusted, and the verniers, marking the observed altitudes, brought together, when the instrument will immediately shew,

1. The latitude of the place of observation, to 15″ of a degree. 2. The distance in time from noon of either observation, to 2″ of time, which compared with a chronometer will give the difference of longitude. 3. The true azimuth, which, compared with a compass bearing, will give the variation of the magnetic pole. The operation may take about three or four minutes, there being no other calculation required than the usual correctness for dip, refraction, &c. in the altitudes; and the like for the declination, from the Nautical Almanack, to adapt it to the place of observation: these being reductions which must take place under any solution of the problem, whether by the calculated forms, or by instrument. Two or three hours' instruction will make any master of a vessel competent to use it.—This account of Bordwine's instrument amounts also to a demonstration, that it is the same as Hunter's, which, however, claims priority of date for its invention.

**NAUTILUS**, in Natural History, a genus of the vermes testacea class and order. The N. pompilius inhabits the Indian and African oceans, often very large, and finely variegated with brown flexuous streaks, spots, and marks under the outer covering, which is white; within of a most beautiful pearly gloss. Of this species, the inhabitants of the East make drinking cups. The shell of N. papyraceus is no thicker than paper, and the fish is not fastened to it. When it is to sail, it expands two of its arms on high, and between these supports a membrane which it throws out on this occasion; this serves for its sail; and the other two arms it hangs out of its shell, to serve occasionally either as oars or as a steerage, but this last office is generally served by the tail. If a storm arises, or any thing gives them disturbance, they draw in their legs, and take in as much water as makes them specifically heavier than that in which they float, and they sink to the bottom. When they rise again, they void this water by a number of holes, of which their legs are full.

**NAVE**, in Architecture, denotes the body of a church, or the place where the people are seated, reaching from the rail or baluster of the choir to the chief door.

NAVE *of a Wheel*, that short thick piece in the centre of a wheel, which receives the end of the axle-tree, and in which the ends of the spokes are fixed.

**NAVIGATION**, the art of sailing, or of conducting a vessel through the ocean, is usually divided into navigation common, and navigation proper; the former relating to what is otherwise called coasting, or traversing the coast or shore of a country, and in which the navigator seldom loses sight of land. And the other, to those voyages made from one country to another, through the trackless paths of the ocean. The origin of navigation, like that of all the arts and sciences of ancient date, is lost in obscurity, some attributing it to one nation, and some to another. The Phœnicians, particularly those of Tyre, are now, however, more generally considered as the first people who made any great advances in this important art. These were afterwards followed up by the Carthaginians, who discovered the Fortunate or Canary Islands, and even, according to some authors, America was visited by this enterprising people, but of this there is not sufficient proof. From Carthage and Tyre commerce and navigation were transferred to Alexandria, which when under the Romans was only inferior to Rome itself, the latter being supplied with its merchandise wholly from the magazines of the former. Constantinople became afterwards the centre of commerce, and navigation was for a long time pursued with great ardour by the merchants of that city; after this time it began to spread itself, though slowly, amongst the several European cities and nations. Genoa and Venice are particularly distinguished for the active part they took in promoting this important branch of human knowledge. The crusades, however, contributed in a great measure to its revival, and the Genoese, the Pisans, and Venetians, who furnished transports to those holy mariners, pushed their discoveries to a great extent. The inventor of the mariner's compass in the fourteenth century completed the wants of sailors. Columbus and Vasco di Gama immortalized themselves in the fifteenth century, and Cook in the eighteenth, by their noble discoveries.

A few plain truths will set the whole art of navigation in a clear light to the most inexperienced.

1. In whatever direction a ship sails, she must steer along some rhumb or point of the compass. Thus, supposing she were going to sail from New Guinea to Niphon, one of the Japan islands, in long. 150° east, her course would be due north along the meridian of 160° east long. If she were going to sail from New Holland to Madagascar, her course would be due west, in the latitude of about 20° south: and so on of her course in any other direction between the four cardinal points of the mariner's compass. Hence,

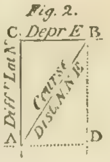
2. *In plane Sailing*, the angle formed by the meridian and rhumb that a ship sails upon, is called the ship's course. Thus, if a ship sails on the N. N. E. rhumb, then her course will be 22 deg. 30 min.; and so of others.

3. The distance between two places lying on the same parallel, reckoned in miles of the equator, or the distance of one place from the meridian of another, counted as above on the parallel passing over that place, is called meridional distance, which in plane sailing goes under the name of Departure.

4. Let A, fig. 2, denote a point to the earth's surface, A C its meridian, and A D the parallel of latitude passing through

it; and suppose a ship to sail from A on the N.NE. rhumb, till she arrives at B, and through B, draw the meridian B D, (which by the principles of plane sailing must be parallel to C A,) and the parallel of latitude B C, then the length of A B is called her distance; A C or B D will be her difference of latitude or northings, C B will be her departure or easting, and the angle C A B will be the courses. 5. Since the distance, difference of latitude, and departure, form a right-angled triangle, in which the oblique angle opposite to the departure is the course, and the other its complement, therefore, having any two of these given, we can, by plane trigonometry, find the rest; and hence arise the following cases of plane sailing.

Fig. 2.



*Case* 1. Course and distance given, to find the difference of latitude and departure.

*Example.* Suppose a ship sails from the latitude 30 deg. 25 min. north, N.NE. 32 miles, fig. 3, required the difference of latitude and departure, and the latitude come to, (by right-angled trigonometry,) we have the following analogy for finding the departure, *viz.*

As radius ...................................... 10·00000

to the distance A C ........................ 32 .... 1·50515
so is the sine of the course A 22 deg. 30 min. ....... 9·58284

to the departure B C .................. 12·25 .... 1·08799
so the ship has made 12·25 miles of departure easterly, or has got so far eastward of her meridian. Then for the difference of latitude or northing the ship has made, we have (by rectangular trigonometry) the following analogy, *viz.*

As radius...................................... 10·000000

to the distance A C..................... 32 .... 1·50515
so is the sine of the course A 22 deg. 30 min........ 9·58284

to the difference of lat. A B..................29·57 1·47077
so the ship has differed her latitude, or made of northing 29·57 minutes.

And since her former latitude was north, and her difference of latitude also north, therefore,

To the latitude sailed from ................ 30° 25′ 0″ N.
add the difference of latitude ............... 00 29 57

and the sum is the latitude come to......... 30 54 57

By this case are calculated the tables of difference of latitude and departure to every degree, point, and quarter-point, of the compass.

*Case* 2. The course and difference of latitude being given, to find distance and departure.

*Example.* A ship in the latitude of 45 deg. 25 min. north, sails NE *by* N½ easterly, (fig. 4,) till she comes to the latitude of 46 deg. 55 min. north: required the distance and departure made good upon that course. Since both latitudes are northerly, and the course also northerly, therefore,

From the latitude come to ......................... 46° 55′
subtract the latitude sailed from..................... 45 25

and there remains .................................. 1 30
the difference of latitude equal to 90 miles. And (by trigonometry) we have the following analogy for finding the departure B D, *viz.*

As radius, sine 90°............................ 10·00000

is to the diff. of lat. A B .................. 90 .... 1·95424
so is the tangent of course A 33·22 ................ 9 91404

to the departure B D 73·84 ................ 1·86828
so the ship has got 73·84 miles eastward of her former meridian. Again, for the distance A D, we have (by trigonometry) the following proportion, *viz.*

As radius .............................. ............ 10·000000

is to the secant of the course .............. 39·22 10·11176
so is the diff. of lat. A B .... .............. 90 *m.* 1·95424

to the distance A D ..... .................. 116·4 2·06600

*Case* 3. The difference of latitude and distance given, to find course and departure.

*Example.* A ship sails from the latitude of 56 deg. 50 min. north, on a rhumb between south and west, 126 miles, and she is then found by observation to be in the latitude of 55 deg. 40 min. north; required the course she sailed on, and her departure from the meridian. (Fig. 5.) Since the latitudes are both north, and the ship sails towards the equator, therefore,

From the latitude sailed from...................... 56° 50′
subtract the observed latitude ...................... 55 40

and the remainder.................................. 1 10
equal 70 miles, is the difference of latitude.—By rectangular trigonometry we have the following proportion for finding the angle of the course F, *viz.*

As the dist. sailed D F ...................... 126° 2·10037

is to radius ................................ 10·00000
so is the diff. of lat. FD...................... 70 1·84510

to the co-sine of the course F ...............56° 15′ 9·74473
which, because she sails between south and west, will be south 56 deg. 15 min. west, or SW *by* W. Then, for the departure, we have (by trigonometry) the following proportion, *viz.*

As radius sine 90° ........... .................. 10·00000

is to the dist. sailed D F ................ 126° 2·10037
so is the sine of the course F .............. 56 15′ 9·91985

to the departure, D E....................... 104·8 2·02022
consequently she has made 104·8 miles of departure westerly.

*Case* 4. The difference of latitude and departure given, to find the course and distance.

*Example.* A ship sails from the latitude of 44 deg. 50 min. north, between south and east, till she has made 64 miles of easting, and is then found by observation in the latitude of 42 deg. 56 min. north; required the course and distance made good. Since the latitudes are both north, and the ship sailing towards the equator, therefore,

From the latitude sailed from ..................... 44° 50′ N
take the latitude come to ......................... 42 56

and there remains ............................... 1 54
equal to 114 miles, the difference of the latitude or southing.

Fig 3.

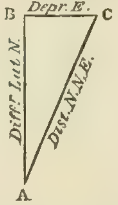
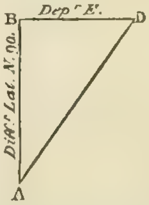
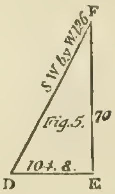
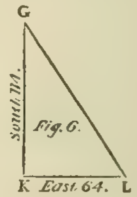


Fig 4.







In this case (by trigonometry) we have the following proportion to find the course K G L, fig. 6,) *viz.*

As the dist. of lat. G K ..................... 114° 2·05690

is to the radius ........................... 10·00000
so is the departure K L...................... 64 1·80618

to the tangent of the course G ............. 29° 19′ 9·74928
which, because the ship is sailing between south and east, will be south 29 deg. 19 min. east, or S S E½ east, nearly. Then for the distance we shall have (by rectangular trigonometry) the following analogy, *viz.*

As radius ........................................ 10·0000

is to the diff. of lat. G K ................ 114° 2·05690
so is the secant of the course.............. 29° 19′ 10·05952

to the distance G L ....................... 132·8 2·11642
consequently the ship has sailed on a S S E½ east course 130·8 miles.

*Case* 5. The distance and departure given, to find course and difference of latitude.

*Example.* A ship sails from the latitude of 34 deg. 24 min. north, between north and west, 124 miles, and is found to have made of westing 86 miles; required the course steered, and the difference of latitude or northing made good. In this case (by trigonometry) we have the following proportion for finding the course A D B, fig. 7, *viz.*

As the distance A D ........................ 121° 2·0934·
is to radius sine 90° ........................ 10·00000
so is the departure A B ........................ 86 1·93450
to the sine of the course D ........................ 43 54′ 9·84108

so the ship's course is north 33 deg. 45 min. west, or NW *by* N¼ west nearly. Then for the difference of latitude we have (by rectangular trigonometry) the following analogy, *viz.*

As radius sine 90° ........................ 10·00000
is to the distance A D ........................124° 2·09342
so is the cosine of the course ... ........................ 43° 54′ 9·85766
to the diff. of lat. B D ........................ 89 35 1·95108

which is equal to 1 degree and 20 minutes nearly. Hence, to find the latitude the ship is in, since both latitudes are north, and the ship sailing from the equator, therefore,

To the latitude sailed from ........................ 34° 24′
add the difference of latitude........................ 1 29

the sum is ........................................ 35 53
the latitude of the ship is in north.

*Case* 6. The course and departure given, to find distance and difference of latitude.

*Example.* A ship at sea, in the latitude of 24 deg. 30 min. south, sails SE*by* S, till she has made of easting 96 miles; required the distance and difference of latitude made good on that course.

In this example (by Case 2) we have the following proportion for finding the distance, fig. 8, *viz.*

As the sine of the course G .............. 33° 45′ 9·74474
is to the departure H M .................. 96 1·98227
so is radius ................................ 10·00000
to the distance G M...................... 172 8 2·29753

Then, for the difference of latitude we have (by rectangular trigonometry) the following analogy, *viz.*

As the tangent of course ................ 33° 45′ 5·82489
is to the departure H M .................. 96 1·98227
so is radius ................................ 10·00000
to the diff. of lat. G H .................. 143 7′ 2·15738

equal to 2 deg. 24 min. nearly. Consequently, since the latitude the ship sailed from was south, and she sailing still towards the south,

To the latitude sailed from........................ 24° 30′
add the difference of latitude ........................ 2 25

and the sum ........................................ 26 55
is the latitude she is come to, south.

*Observation.* When a ship sails on several courses in 24 hours, the reducing of all these into one, and thereby finding the course and distance made good upon the whole, is commonly called the resolving of a traverse. At sea, they commonly begin each day's reckoning from the noon of that day, and from that time they set down all the different courses and distances sailed by the ship till noon next day, upon the log-board; then from these several courses and distances, they compute the difference of latitude and departure for each course, by Case 1, of Plane Sailing, and these, together with the courses and distances, are inserted in the Traverse Table, which consists of five columns; in the first are placed the courses and distances, in the two next, the differences of latitude, north or south, belonging to these courses; and in the two last, the departures, east or west, belonging to these courses. Then the persons who keep these reckonings, sum up all the northings and all the southings, and taking the difference of these, they know the difference of latitude made good by the ship in the last 24 hours, which will be north or south, according as the sum of the northings or southings is greatest. In the same manner, by taking the sum of all the eastings, and likewise of all the westings, and subtracting the lesser of these from the greater, the difference will be the departure made good by the ship during the last 24 hours, which will be east or west, according as the sum of the eastings is greater or less than the sum of the westings; then from the difference of latitude and departure made good by the ship in the last 24 hours, found as above, they find the true course and distance made good upon the whole, (by Case 4, of Plane Sailing,) as also the course and distance to the intended port.

*Of Parallel Sailing.* Since the parallels of latitude are concentric circles to the axis of the earth, they always decrease the nearer they approach the pole; it is plain, therefore, that a degree of longitude on any of them must be less than its corresponding degree of longitude upon the equator. See the Table of DEGREES of LONGITUDE.

Now, to know the length of a degree on any of them, let P B, fig. 9, represent half the earth's axis; P A a quadrant of a meridian, and consequently A a point of the equator; C a point on the meridian, and C D a perpendicular from that point upon the axis, which plainly will be the sine of C P, the distance of that point from the pole, or the co-sine of C A its distance from the equator; and C D will be to A B as the sine of C P, or co-sine of C A, is to the radius. Again, if the quadrant P A B is turned round upon the axis P B, it is plain the point A will describe the circumference of the equator whose radius is A B, and any other point C upon the meridian will describe the circumference of a parallel whose radius is C D.

*Fig. 7.*

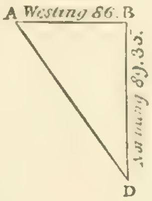


*Fig. 8.*

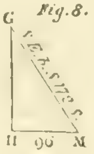


*Fig. 9.*

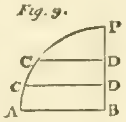
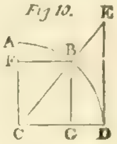


*Fig. 10.*



*Cor.* 1. Hence (because the circumferences of circles are as their radii) the circumference of any parallel is to the circumference of the equator, as the co-sine of its latitude is to radius. 2. And since the wholes are as their similar parts, the proportion will be, as the length of a degree on any parallel, is to the length of the degree upon the equator, so is the co-sine of the latitude of that parallel to radius. 3. Hence, also, as radius is to the co-sine of any latitude, so are the minutes of difference of longitude between two meridians, or their distance in miles upon the equator, to the distance of these two meridians on the parallel in miles. 4. And, as the co-sine of any parallel, is to radius, so is the length of any arc on that parallel (intercepted between two meridians) in miles, to the length of a similar arc on the equator, or minutes of difference of longitude. 5. Also, as the co-sine of any one parallel, is to the co-sine of any other parallel, so is the length of any arc on the first in miles, to the length of the same arc on the other in miles.

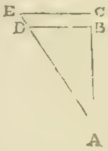
*Of Mercator's Sailing.*—Though the meridians all meet at the pole, and the parallels of latitude from the equator to the pole continually decrease, and that in proportion to the co-sines of their latitudes; yet in sea-charts the meridians are drawn parallel to one another, and consequently the parallels of latitude made equal to the equator, and so a degree of longitude on any parallel is as large as a degree of longitude on the equator; also in these charts the degrees of latitude were still represented (as they are in themselves) equal to each other, and to those of the equator. By these means the degrees of longitude being increased beyond their just proportion, and the more so the nearer they approach the pole, the degrees of latitude at the same time remaining the same, it is evident places marked down upon these charts with respect to their latitude and longitude, and consequently their bearing from one another, must be very false. To remedy this inconvenience, so as still to keep the meridians parallel, we lengthen the degrees of latitude in the same proportion as those of longitude are, that the proportion in easting and westing may be the same with that of southing and northing, and consequently the bearings of places from one another are the same upon the chart as upon the globe itself.

Let A B, fig. 10, be a quadrant of a meridian, A the pole, D, a point on the equator, A C half the axis, B any point upon the meridian, from which draw B F, perpendicular to A C, and B G perpendicular to C D; then B G will be the sine, and B F or C G the co-sine of B D the latitude of the point B: draw D E the tangent and C E the secant of the arc C D. Then, since any arc of a parallel is to the like arc of the equator, as the co-sine of the latitude of that parallel is to radius. Thus any arc, as a minute on the parallel described by the point B, will be to a minute on the equator, as B F or C G is to CD; but since the triangles C G B, C D E are similar, therefore C G will be to C D as C B is to C E, *i. e.* the co-sine of any parallel is to the radius, as the radius is to the secant of the latitude of that parallel. But the co-sine of any parallel is to radius, as the length of any arc (as a minute) on that parallel is to the length of the like arc on the equator: therefore the length of any arc (as a minute) on any parallel, is to the length of the like arc on the equator, as radius is to the secant of the latitude of that parallel; and so the length of any arc (as a minute) on the equator, is longer than the like arc of any parallel in the same proportion as the secant of the latitude of that parallel is to radius. But, since in this projection the meridians are parallel, and consequently each parallel of latitude is equal in absolute length to the equator, it is plain the length of any arc (as a minute) on any parallel is increased beyond its just proportion, at such rate as the secant of the latitude of that parallel is greater than radius: and therefore to keep up the proportion of northing and southing to that of easting and westing, upon this chart, as it is actually upon the globe itself, the length of a minute, upon the meridian at any parallel, must also be increased beyond its just proportion at the same rate, *i. e.* as the secant of the latitude of that parallel is greater than radius. Thus, to find the length of a minute upon the meridian at the latitude of 75 deg. since a minute of a meridian is every where equal on the globe, and also equal to a minute of latitude upon the equator, let it be represented by unity, then making it as radius to the secant of 75 deg. so is unity to a fourth number, which is 3·864 nearly; and consequently, by whatever line you represent one minute on the equator of this chart, the length of one minute on the enlarged meridian at the latitude of 75 deg. or the distance between the parallel of 75 deg. 00 min. and the parallel of 75 deg. 01 min. will be equal to three of these lines, and $\frac{864}{1000}$ of one of them. By making the same proportion, it will be found that the length of a minute on the meridian of this chart at the parallel of 60 deg. or the distance between the parallel of 60 deg. 00 min. and that of 60 deg. 01 min. is equal to two of these lines. After the same manner the length of a minute on the enlarged meridian may be found at any latitude; and consequently beginning at the equator, and computing the length of every intermediate minute between that and any parallel, the sum of all these shall be the length of a meridian intercepted between the equator and that parallel; and the distance of each degree and minute of latitude from the equator upon the meridian of this chart, computed in minutes of the equator, forms what is commonly called a table of meridional parts, as is that given in our directions for the construction of Mercator's chart in the article MAPS.

If the arc B D of the foregoing figure represents the latitude of any point B, then (C D being radius) C E will be the secant of that latitude; but it has been shewn above, that radius is to secant of any latitude, as the length of a minute upon the equator, is to the length of a minute on the meridian of this chart at that latitude; therefore, C D is to C E, as the length of a minute on the equator is to the length of a minute upon the meridian at the latitude of the point B. Consequently if the radius C D is taken equal to the length of a minute upon the equator, C E, or the secant of the latitude will be equal to the length of a minute, upon the meridian of that latitude. Therefore, in general, if the length of a minute upon the equator is made radius, the length of a minute upon the enlarged meridian will be every where equal to the secant of the arc contained between it and the equator.

Hence, since the length of every intermediate minute between the equator and any parallel is equal to the secant of the latitude, (the radius being equal to a minute upon the equator) the sum of all these lengths, or the distance of that parallel on the enlarged meridian from the equator, will be equal to the sum of all the secants to every minute contained between it and the equator. Consequently the distance between any two parallels on the same side of the equator, is equal to the difference of the sums of all the secants contained between the equator and each parallel; and the distance between any two parallels on contrary sides of the equator, is equal to the amount of the sums of all the secants contained between the equator and each parallel. Hence, by the tables of meridional parts may be constructed Mercator's nautical chart.

*Fig 11.*



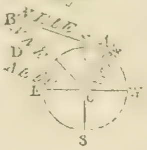
In fig. 11. Let A and E represent two places upon Mercator's chart, A C the meridian of A, and C E the parallel of latitude passing through E; draw A E, and set off upon A C the length A B equal to the number of minutes contained in the difference of latitude between the two places, and taken from the same scale of equal parts by which the chart was constructed, or from the equator, or any graduated parallel of the chart, and through B draw B D parallel to C E, meeting A E in D. Then A C will be the enlarged difference of latitude, A B the proper difference of latitude, C E the difference of longitude, B D the departure, A E the enlarged distance, and A D the proper distance between the two places A and E; also the angle B A D will be the course, and A E the rhumb-line between them.

*Of Oblique Sailing.*—The questions that may be proposed on oblique sailing are innumerable; we shall therefore select one as an example.

Coasting along the shore, I saw a cape bear from N N E; then I stood N W *b* W 20 miles, and I observed the same cape bear from me N E *b* E: required the distance of the ship from the cape at each of those stations.

Geometrically.—Draw the circle N W E S fig. 17, to represent the compass, N S the meridian, and W E the east and west line, and let C be the place of the ship in her first station; then from C set off upon the N W *b* W line, C A 20 miles, and A will be the place of the ship in her second station. From C draw the N N E line C B, and from A draw A B parallel to the N E *b* E line C D, which will meet C B in B, the place of the cape, and C B will be the distance of the ship from it in its first station, and A B the distance in the second. The angle D C E is equal to the angle N C A, hence the parallelism of the lines D C, B A. To find which by calculation:—In the triangle A B C are given A C, equal to 20 miles; the angle A C B equal to 78 deg. 45 min. the distance between the N N E and N W *b* W lines: also the angle A B C equal to B C D equal to 33 deg. 45 min. the distance between the N N E and N E *b* E lines; and consequently the angle A, equal to 67 deg. 30 min.

*Fig. 17.*



Hence, for C B, the distance of the cape from the ship in her first station, the proportion will be (by oblique trigonometry)

S. A B C : A C : : S. B A C : C B.

| | | | |
|---|---|---|---|
| *i e.* As the sine of the angle B | 33° | 34′ | 9·74473 |
| is to the distance run A C | 20 | — | 1·30163 |
| so is the sine of B A C | 67 | 30 | 9·96562 |
| to C B | 33 | 26 | 1·52191 |

the distance of the cape from the ship at the first station. Then for A B it will be, (by oblique trigonometry,)

S. A B C : A C : : S. A C B : A B.

| | | | |
|---|---|---|---|
| *i.e.* As the sine of B | 33° | 45′ | 9·74474 |
| is to A C | 20 | — | 1·30163 |
| so is the sine of C | 78 | 45 | 9·99157 |
| to A B | 35·31 | | 1·54786 |

to the distance of the ship from the cape at her second station.

*Of the Log Line and Compass.*—The method commonly made use of for measuring a ship's way at sea, or how far she runs in a given space of time, is the log line and a half-minute glass. —*See* LOG.

Of the compass we may observe, that the meridian and prime vertical of any place cuts the horizon in four points, at 90 deg.

distance from one another, *viz.* north, south, east, and west: that part of the meridian which extends itself from the place to the north point of the horizon is called the north line; that which tends to the south point of the horizon is called the south line; and that part of the prime vertical which extends towards the right hand of the observer when his face is turned to the north, is called the east line; and lastly, that part of the prime vertical which tends towards the left hand, is called the west line; the four points in which these lines meet the horizon are called the cardinal points.

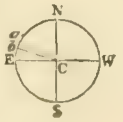
In order to determine the course of the wind, and to discover the various alterations or shiftings, each quadrant of the horizon, intercepted between the meridian and prime vertical, is usually divided into eight equal parts, and consequently the whole horizon into thirty-two; and the lines drawn from the place on which the observer stands, to the points of division in his horizon, are called rhumb-lines; the four principal of which are those described in the preceding paragraph, each of them having its name from the cardinal point in the horizon towards which it tends: the rest of the rhumb-lines have their names compounded of the principal lines on each side of them, as in the figure; and over whichsoever of these lines the course of the wind is directed, that wind takes its name accordingly. *See* COMPASS.

*Concerning Currents, and the method of making proper allowances for their effects upon a ship's way.*—Currents are certain settings of the stream, by which all bodies (as ships, &c.) moving therein, are compelled to alter their course or velocity, or both, and submit to the motion impressed upon them by the current. The great and general currents are from east to west throughout the tropical regions, and from north to south towards the equator, coinciding with the regular tropical winds. Along the shores of continents and islands they are often diverted from their natural course, and being sometimes concentrated into a narrow channel, acquire an almost preternatural velocity; as the great current from east to west along the American continent. *See* CURRENT. The northern seas are chiefly moved by the action of the polar current, extending along even the whole coast of Britain from the Orkneys southward.

*Case* 1. If the current sets just the course of the ship, *i.e.* moves on the same rhumb with it; then the motion of the ship is increased, by as much as is the drift or velocity of the current.

*Case* 2. If the current sets directly against the ship's course, then the motion of the ship is lessened by as much as is the velocity of the current.

*The method of keeping and correcting a journal at sea, by making proper allowances for the lee way, variation, &c.*— 1. Lee way is the angle that the rhumb-line, upon which the ship endeavours to sail, makes with the rhumb she really sails upon. This is occasioned by the force of the wind or surge of the sea, when she lies to the windward, or is close-hauled, which causes her to fall off and glide sideways from the point of the compass she capes at. Let NESW represent the compass; and suppose a ship at C capes at, or endeavours to sail upon, the rhumb C *a*; but by the force of the wind, and surge of the sea, she is obliged to fall off, and make her way good upon the rhumb C *b*; then the angle *a* C *b* is the lee way; and if that angle is equal to one point, the ship is said to make one point lee way; and if equal to two points, the ship is said to make two points lee way. The quantity of this angle is very uncertain, because some ships, with the same quantity of sail, and with the same gale, will make more lee way than others.



*To find the lee way.*—Let the ship's wake be set by a compass in the poop, and the opposite rhumb is the true course made good by the ship; then the difference between this and the course given by the compass in the binnacle, is the lee way required. If the ship is within sight of land, then the lee way may be exactly found by observing a point on the land which continues to bear the same way; and the distance between the point of the compass it lies upon, and the point the ship capes at, will be the lee way. Having the course steered, and the lee way given, we may from thence find the true course thus: Let your face be turned directly to the windward; and if the ship has her larboard tacks on board, count the lee way from the course steered towards the right hand; but if the starboard tacks are on board, then count it from the course steered towards the left hand. Thus, suppose the wind at north, and the ship lies up within six points of the wind, with her larboard tacks on board, making one point lee way; here it is plain, that the course steered is ENE, and the true course E *by* N; also suppose the wind is at NNW, and the ship lies up within 6½ points of the wind, with her starboard tack on board, making 1½ point lee way, it is evident that the true course, in this case, is WSW.

We have this general rule for finding the ship's true course, having the course steered and the variation given, *viz.* let your face be turned towards the point of the compass upon which the ship is steered; and if the variation is easterly, count the quantity of it from the course steered towards the right hand; but if westerly, towards the left hand; and the course thus found is the true course steered. Suppose the course steered is N *by* E, and the variation one point easterly, then the true course steered will be NNE; also suppose the course steered is NE *by* E, and the variation one point westerly, then in this case the true course will be NE, and so of others. Hence, by knowing the lee way, variation, and course steered, we may from thence find the ship's true course; but if there is a current under foot, then that must be tried, and proper allowances made for it. After making the proper allowances for finding the ship's true course, and making as just an estimate of the distance as we can; yet by reason of the many accidents that attend a ship in a day's sailing, the latitude by account frequently differs from the latitude by observation, and when that happens, there must be some error in the reckoning; to discover which, and make its correction the reckoning, you may observe the following rules:—1st. If the ship sails near the meridian, or within 2 or 2½ points thereof, then if the latitude by account disagrees with the latitude by observation, it is most likely that the error lies in the distance run; for it is plain, that in this case it will require a very sensible error in the course to make any considerable error in the difference of latitude, which cannot well happen if due care is taken at the helm, proper allowances are made for the lee way, variation, and currents. Consequently, if the course is pretty near the truth, and the error in the distance runs regularly through the whole, we may, from the latitude obtained by observation, correct the distance and departure by account, by the following analogies, *viz.*

As the difference of latitude by account is to the true difference of latitude,

So is the departure by account
to the true departure,
And so is the direct distance by account
to the true direct distance.

If the courses are for the most part near the parallel of east and west, and the direct course is within 5½ or 6 points of the meridian; then if the latitude by account differs from the observed latitude, it is most probable that the error lies in the course or distance, or perhaps both.

The form of the Log-book and Journal, together with an example of a day's work, are here subjoined.

To express the days of the week, mariners commonly use the characters by which the sun and planets are expressed, *viz.* ☉ denotes Sunday, ☾ Monday, ♂ Tuesday, ☿ Wednesday, ♃ Thursday, ♀ Friday, ♄ Saturday, called respectively *Dies Solis, Dies Lunæ, Dies Martii, Dies Mercurii, Dies Jovis, Dies Veneris, Dies Saturnii.*

From the following table it will be seen, that the ship by account, has come to the latitude of 47 deg. 46 min. north, and has differed her longitude 2 deg. 5 min. westerly; so this day I have made my way good, south 31 deg. 31 min. west, distance 157·4 miles.

At noon the Lizard bore from me north 31 deg. 31 min. east, distance 157·4 miles; and having observed the latitude, I found it agreed with the latitude by account. *See* LONGITUDE.

*The Form of the Log Book, with the Manner of working Days' Works at Sea.*

THE LOG BOOK.

| H | K | ½ K | Courses. | Winds. | Observations and accidents.<br>☾ —— day of —— |
|---|---|---|---|---|---|
| 1 | | | | | Fair weather: at four this afternoon I took my departure from the Lizard in the lat. of 5 deg. 00 min. N. it bearing NNE, distant 5 leagues. |
| 2 | | | | North. | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | 7 | | SW *by* S | N *by* E | |
| 6 | 7 | | | | |
| 7 | 7 | 1 | | | |
| 8 | 7 | 1 | | | |
| 9 | 6 | | | | |
| 10 | 6 | | | | The gale increasing,and being under all our sails. |
| 11 | 6 | | SSW | E *by* S | |
| 12 | 6 | 1 | | | |
| 1 | 6 | 1 | | | After three this morning, frequent showers, with thick weather till near noon. |
| 2 | 6 | 1 | SW*by*W | NNE | |
| 3 | 6 | 1 | | | |
| 4 | 7 | | | | |
| 5 | | 1 | | | |
| 6 | | | | | |
| 7 | 8 | | | | The variation I reckon to be one point westerly |
| 8 | 8 | | SW | ENE | |
| 9 | 8 | 1 | | | |
| 10 | 9 | | | | |
| 11 | 8 | 1 | SW ½ W | NE*by*E | |
| 12 | 8 | | | | |

THE LOG BOOK.

| Courses correct. | Dist. | Diff. | Lat. | Diff. | Long. |
|---|---|---|---|---|---|
| | | N. | S. | E. | W. |
| SSW | 50 | | 46·2 | | 29·4 |
| S *by* W | 19 | | 18·6 | | 5·5 |
| SW | 49 | | 29·7 | | 45·5 |
| SW *by* S | 24·5 | | 20·2 | | 20·0 |
| SW ½ S | 25·5 | | 19·5 | | 19·5 |
| | | | 144·2 | | 125·0 |

*Inland* NAVIGATION, expresses more properly what relates to canals, rivers, and lakes, than the ordinary but well known word *Canal.* Egypt, the cradle of science, was the birth-place of the earliest canals, one of which, according to Herodotus, (lib. ii.) passed from the river Nile to the Red sea, and so vast that four ships could pass abreast. Its navigation was performed in four days. Aristotle (Met. lib. i. cap. 14.) says, a king attempted to draw a canal from the Red sea to the Nile, but abandoned the work because the Red sea was higher than the land of Egypt. Diodorus Siculus (lib. ii.) makes it communicate with the Pelusiac branch of the Nile. Strabo affirms, that in his time (lib. i. and xvii.) the merchants of Alexandria formed an outlet from the Nile in the Arabic gulf, to go on to India. It was, he adds, of 100 cubits breadth, and of depth sufficient for the largest vessels. Pliny says, (lib. xxvi. cap. 29 and 33.) it began near Bubasto, and went to the Red sea. The geographer Ptolemy calls it Trajan's river. During the glory of the Mahomedan conquests, Amrow, who conquered Egypt about 635, opened this canal from the Nile to Quotzoum on the Red sea, to convey the contributions of corn into Arabia. Elkmain tells us that it was shut up again by the Caliph Almanzor in 773. China abounds in canals, yet India is devoid of such means of transporting the produce of its rich soil; Persia has no inland navigation worth mentioning; Greece and Italy are alike destitute of these moveable roads, which afford in Holland, France, and Britain, such facilities to commerce. The United States of America now begin to rival France in canals. The canals in England are both numerous and grand; but outdone, perhaps, by the Forth and Clyde canal, and certainly by the Caledonian canal, which opens a communication between the Atlantic on the western coast of Scotland, and the German ocean, at the Murray Frith. The latter passes through Loch Ness, and allows vessels, drawing 18 feet water, to be tracted along. See the plan and details of this canal on the plate. But the canal in agitation to be cut between the English Channel and the Severn, to open a communication across the country, without doubling the Land's End, will be the most advantageous work of the kind constructed in England.

*Theory of Canal Cutting.*—It is evident, that in cutting canals, no farther excavation is required than that which will hold the water at the given depth and breadth; and since, according to the modern practice, a bank on either side is likewise made with the stuff excavated, it is evident, that if we make that bank of sufficient strength and closeness to contain the water, the level of the surface of the canal may be thereby raised above the natural surface of the land, and great part of the excavation saved. One of the first objects, therefore, in canal cutting, is to know at what height above the surface of the land the canal may be carried on level ground, when the excavated stuff or cutting will just make the banks. This is called level cutting. When the ground along which the canal is carried has a declivity, the quantity of stuff to be applied to one bank is necessarily greater than that wanted for the other. This disparity may increase until the one bank vanishes, and the canal is cut entirely along the side of the hill, and only the lower bank is required to be made.

This is the simplest case of canal cutting, and the work admits of being laid out in a much more expeditious way than has commonly been employed, as will be seen: this case is called side cutting, or oblique cutting; the slope of the cut which is made in the hill being made the same as the exterior of the canal bank. These two lines in the section are parallel to each other; and there is a certain point in the section, through which, if any line be drawn, representing the surface of the ground in any case, which line we shall call the line of cutting, the portion of the section thereby exhibited as excavation, will always be equal to that exhibited as embankment. We shall call this point the centre of cutting.

PROBLEM I.—Given the outline section or profile of a canal in sidelong ground, with parallel slopes. To find the centre of cutting.

*Case* 1. For one bank only. See plate I. CANALS, fig. 1.

Given A B C D a section of the canal, C D E G F, a section of the bank. To find the centre of cutting.

Produce the lines B C and E D to G and A. Draw the perpendiculars C *m*, D *n*, and the diagonals A G, *m n* intersecting in *p*. Through *p* draw the parallel *s p t*, and bisect it in *o*; *o* is the centre of cutting, through which, if any line H *o* F be drawn cutting the slopes A B and E G produced, the section H B C *w* will always be equal to *w* D E F.

The centre of cutting is also the centre of cut and cover, for H *o* is always equal to *o* F. Hence, if a line be staked out along the ground at the level of the centre of cutting, it will exhibit the middle of the ground wanted for the use of the canal, whatever may be the inclination of the surface, at least if that inclination be regular as far as the breadth required; and the distance *o* H or *o* F, on each side of the centre, may easily be found by a line drawn across the section with the given inclination of the ground.

The distance of the centre of cutting, from the centre of the canal at surface water, is equal to $u q +$ D E. Hence, if the line of the middle of the cut and cover be laid out, or the centre of cutting, we may lay out a set of stakes at a certain horizontal distance therefrom; and the top of these stakes being made even with the level of surface water, they will exhibit the line of the middle of the canal when finished.

At half the general breadth A E, from the centre of cutting,

# INLAND NAVIGATION.

## THE THEORY & PRACTICE OF CUTTING CANALS.

Fig. 1.
*Prob. I. Case I.*

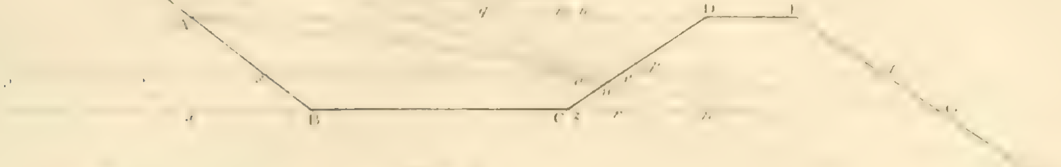


Fig. 2.
*Prob. I. Case 2.*

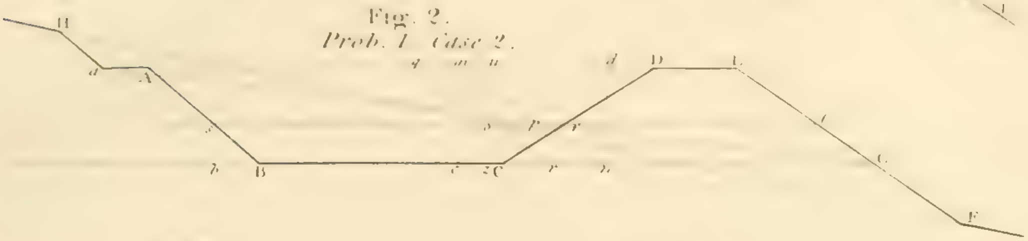


Fig. 3.
*Prob. II.*

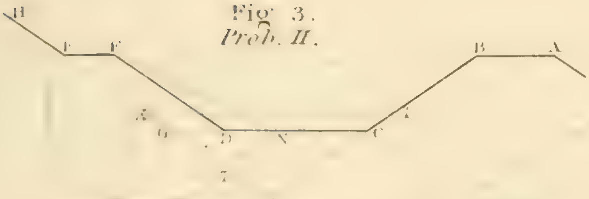


Fig. 4.
*Prob. III.*

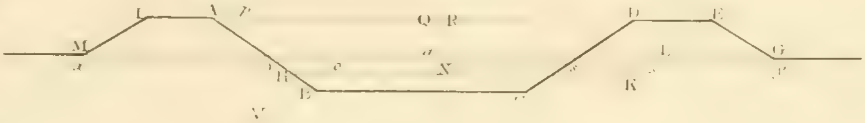


Fig. 5.
*Prob. IV.*

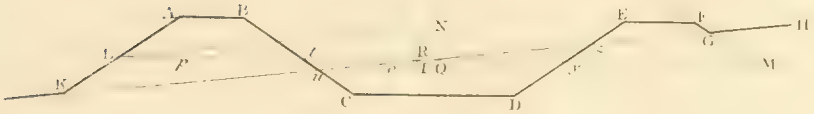
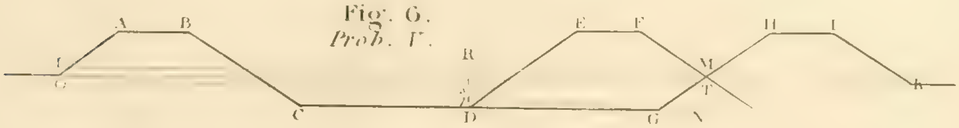


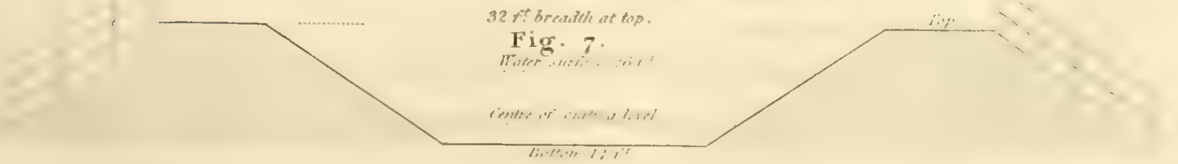
Fig. 6.
*Prob. V.*



**WORKING SECTION OF CUTTING FOR A CANAL.**

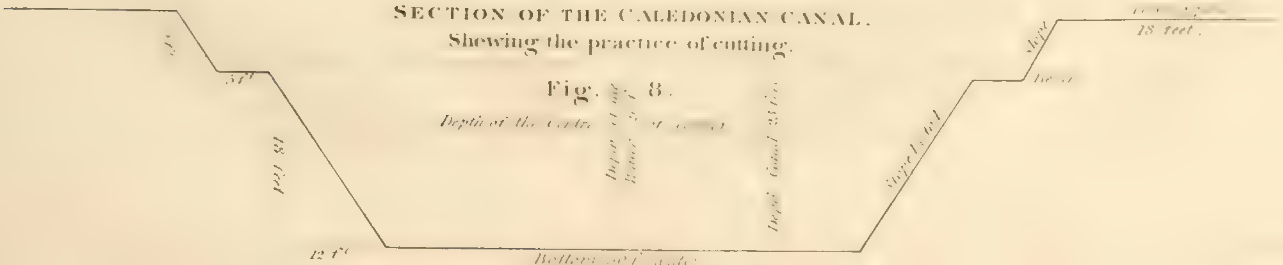
*32 f.t breadth at top.*

Fig. 7.



**SECTION OF THE CALEDONIAN CANAL.**
Shewing the practice of cutting.

Fig. 8.



and on that level, is a point in the exterior slope of the bank, and a line of stakes may be set out at that distance and level, which will direct the wheeling of stuff for the formation of the bank. And at these stakes a level and plumb line may be applied, with the slope of the bank, by which the point F, where the exterior slope of the bank meets the surface of the land, will be found, and may be marked out, and the edge of excavation will be at an equal distance on the other side of the centre of cutting.

At the same distance, *viz.* half the general breadth A E, and on the upper side of the centre of cutting, at its level is the point *s*, in the inner slope of the excavation.

The horizontal distance *o v*, of the inner slope of the bank from the centre *o*, will be found by saying E *n* : *n* C :: *z o* : *o v;* a line of stakes may therefore be placed at this distance and level, to direct the wheeling as above, and by a level and plumb, the commencement of the bank and excavation may be marked in the same way.

The quantity of excavation above the level of the centre of cutting is the triangle *o s* H, and the base *o s* will always be proportional to the height H *y* of the upper edge above the level.

The quantity of excavation below the level of the centre of cutting, differing from *s* B C *v* only by the small triangle *o w v*, of which the base *o v* being constant, the area is proportioned to the perpendicular from *w* to the level of the centre of the cutting.

*Case* 2, fig. 2. When there is a towing path on the upper side, given *a* A B C D E G, as before, the profile of the path, canal, and bank, take D *d* = *a* A, draw *a b* and *c d* parallel to the slopes, thereby converting the section *a* A B C D E into *a b c d* E, in which the towing path is supposed to be added to the bank; proceed to draw the lines *a* G, *c d*, and *s t;* the middle *o* will be the centre of cutting.

PROBLEM II.—Fig. 3. To reduce the section A B C D E F with a second bench or path E F, to the equivalent section A B I K F, with one bank only, but wider and shallower, the banking cut down and filled into the bottom.

Produce B C and H F to Z, also C D to G; make D N = D G. Draw the parallel N L (or, if the slopes are all equal, make D L perpendicular to G C,) on F L, describe the semicircle L M F, cutting the perpendicular G M; make Z K (and Z I) equal to Z M; draw the parallel K I, and it is done.

The height of I K over C G is nearly found by the slopes.

PROBLEM III.—Fig. 4. Given the profile of a canal with two banks, the slopes being all equal. To find the lines of level cutting.

Reduce the section A B C D into A H K E. For this find *o*, the centre of cutting. Produce each slope to meet in V; draw the perpendiculars V N, O N; with centre N and radius N V cut E A in *p*; make V *a* = P Q, and through *a* parallel to E A draw M L the line of level cutting.

PROBLEM IV.—Fig. 5. Given as in last problem. To find any line of oblique cutting.

Find the line of level cutting. Produce the slopes to meet in V. Draw the perpendicular V I; from L draw L N with the given slope of the ground, cutting V I in N, making N *p* and *p* Q = V I, also V R = *p* I. Through R draw K R H for the line of oblique cutting required.

If the slopes are parallel, then N R = N I, and I is the centre of cutting. The centre cutting over level cutting, in this case of oblique shallow cutting, is the difference between *o z y* and *c t u.*

PROBLEM V.—Fig. 6. Given the profile of a canal, as in last case, and the line of ground level too low for level cutting. Required to widen the canal so as to have cutting for the banks.

It is obvious, that the trapezoid O M must be provided for by the parallelogram D Q, wherefore draw the perpendiculars M N, D *p*, and make D *p* = R S. Draw the parallels O N and P Q; D G is the additional width, or C G is the mean bottom.

Or, by calculation, as N T : T O, so *p* D = R *s* : D C.

T O is formed from L M by adding the slope base for the height M T at each end, and is usually L M + 3 M T, or 3 R S.

A similar problem to the above may be given for narrowing the canal in deep cutting; but this is of less use; and it is evident, that when the ground O K is at or below the bottom C D, the problem is impossible, and the case becomes one of embankment.

*Examples.* Fig. 7. Given a canal of 14 feet bottom, 26 feet water surface, the banks rising two feet over water, and 10 feet broad at top, slopes being $1\frac{1}{2}$ to 1, required the centre of cutting:

26 — 6 total depth.
$6 = 2 \times 3$ — $1\frac{1}{2}$
32 breadth at top. — 9 inner slope.
10 — 10 top bank.
42 — 10
6
$42\,)\,60\,( = 1\frac{3}{7}$ feet, the height of the centre of cutting over the bottom of the canal.
42
18
$\frac{18}{42} = \frac{3}{7}$

$\frac{42}{2} = 21$ feet, is its distance from the inner slope of the upper, and from the outer slope of the lower side. From 6 deduct $1\frac{3}{7}$, and there will remain $4\frac{4}{7}$, which multiplied by $1\frac{1}{2}$ will give $6\frac{6}{7}$, to which add 5 the half breadth of top bank, and the sum $11\frac{6}{7}$ is the distance from the middle of the canal.

$1\frac{3}{7} \times 3 = 4\frac{2}{7}$
14 bottom.

$18\frac{2}{7}$ breadth of canal at level of centre.
21 half total breadth ditto.

$2\frac{5}{7}$ distance of centre from outer slope of the canal; and it is evident, that the centre of cutting is in the bank in this case.

*Example.* Fig. 8. The Caledonian Canal has 50 feet bottom, and 20 feet water; the slopes are $1\frac{1}{2}$ to 1, to within two feet of surface water, where there is a bench or retreat of five feet; above this the banks rise five feet with a slope of two to one, and are 18 feet wide at top. On the upper side, in side-cutting, there is a bench or towing path of 10 feet. The area of the part on each side over the bench or retreat, if the inner slope was carried to the top, would be,

$(5 + 7\frac{1}{2}) \times \frac{5}{2} = 31\frac{1}{4}$, and the breadth at top is $7\frac{1}{2}$ feet.

$$\frac{31\frac{1}{4}}{23} \times 2 = \frac{62\frac{1}{2}}{23} = 2\tfrac{33}{46}.$$

So that the space contained over these benches is equivalent to widening the canal $2\frac{33}{46}$. The depth $23 \times 1\frac{1}{2} = 34\frac{1}{2}$, is the base of the inner slope if produced to the level of the top of the banks; whence $50 + 2 \times 34\frac{1}{2} = 119$, would in that case be the width of the canal. Also, $18 + 7\frac{1}{2} = 25\frac{1}{2}$ would be the breadth at top of the bank, and $10 + 7\frac{1}{2} = 17\frac{1}{2}$ would be the breadth of the upper bank; their sum, 43 feet, must be diminished by $2\frac{33}{46}$, and the width of canal increased by the same quantity, to allow for the recesses at top. Then say, as total width $119 + 43 = 162$ canal and banks to $43 - 2\frac{33}{46} + 34\frac{1}{2} = 74\frac{36}{46}$ top bank and one slope. So depth of canal 23. To depth below centre of cutting $10\frac{50}{81}$, and consequently, the depth of said centre from the top, is $23 - 10\frac{50}{81} = 12\frac{31}{81}$.

*Of the Form of Locks.*—The most natural form of the lock is that which approaches, as nearly as possible, to the figure of the boats which are to use it. The width must be only a little more than that of the boat, and it must be the same throughout, as the boat has to pass along the whole lock; and the length may only exceed that of the boat by a space sufficient to admit of working the gates. A long rectangle is therefore the natural figure. It consumes the smallest quantity of water in passing the boat; is filled and emptied in the shortest time; and, on the whole, is constructed at less expense than any other form. See fig. 5, Caledonian Canal.

Having thus determined the preference to be given to locks of a rectangular form to those of a circular form, as in the canal of Languedoc, or the circular lock at Agde, figs. 1 and 3, our next object is to consider their length and breadth. This must depend on the size of the vessels for which the locks are intended. When the vessels are to be navigated also on rivers or the sea, the breadth of the locks must be more considerable than where canal boats are intended to pass; for in rivers the shallow water frequently met with, obliges us to give the vessel an excess of breadth, so that her draft may be diminished as much as possible; whereas, in canals, we are masters of the depth of water, and find it more economical to restrict the breadth as much as possible, as we thereby diminish the evaporation, the expense of cutting, and the purchase of property. Dr. Anderson, and other writers on the subject of small canals, have not attended sufficiently to this matter, when they recommended widening the surface only of small canals in order to give a greater facility of trackage.

In our English canals, the usual size of boats supposed fit for the navigation of rivers and canals alternately, is one of 14 feet beam. Where the canals are intended also to be used by coasters, greater widths are adopted. Thus the Forth and Clyde Canal admits vessels of 19 feet beam; and the Caledonian canal, which is a canal of transit for sea-going ships, admits vessels of 39 feet wide; but in the great majority of canal navigations in England, a much smaller width has been adopted. Seven feet beam has been the usual size in the central canals, and still narrower boats have been proposed; but they become liable to many inconveniencies, and can only be employed in the transport of very heavy substances, such as ores or minerals. The narrow boat has the advantage of being navigated with more ease, and of causing less expense in lock-gates, bridges, &c.

*Length and Breadth of Locks.*—The length and breadth of lock chambers ought to be necessarily regulated by the form of the boats that are to pass upon the canals. It is common to make this kind of boats longer and narrower than those of rivers, which, on account of the small depth of water found in some places, are obliged to be made as flat as possible. In canals, on the contrary, we are able to give a considerable depth to the water, but we do not give them great breadth, so that there may be less evaporation, less earth to be removed, and less ground to be occupied. There is commonly no more breadth given to canals than what is necessary for enabling two boats to navigate with ease beside each other, and even in the difficult parts, such as those which are cut in rock, there is often no more breadth given than what is necessary to pass a single boat, only some places are made wider, at which one boat may lie by, while another one passes in an opposite direction. Besides, a principal object in making use of narrow boats on navigable canals, is to diminish the breadth of the lock-gates, which wear longer, and are more easily worked, than when they are broad. Narrow boats are also more easily drawn than those which are wider and shorter. But what ought principally to regulate the width and breadth of locks are the dimensions of those in the canals already executed, and through which the boats of the new canal may have to pass.

Coehorn, in his fortification, has given a very ingenious construction for a retaining wall. His designs were intended for the soil of Holland, where stone is not to be found, and it behoved him to be as sparing of masonry as possible. His wall is only three feet thick, battering considerably in front, and leaning nearly as much behind, supported by long and thin counterforts, which are connected together by two rows of arches, one over the other; and also by two walls arched horizontally against the earth. The intervening spaces are filled with gravel and splinters for the purposes of defence, which is also the reason of his counterforts being made so long, and connected by double walls. Coehorn does not give this as his own invention, though he describes it very carefully, but as having been adopted by him from some older German authors.

Gauthey, a civil engineer in the French service, who constructed the canal of Charolois, or of the Centre, about thirty years ago, has published a very sensible paper on the subject of walls, in the Memoirs of the Academy of Dijon. After criticising the theories of Couplet and others, given in the Transactions of the Academy of Paris, and the profiles of Belidor and Vauban, he proceeds to shew, by experiments made with sand and shot against a smooth plane, that the pressure acts at the centre of gravity, or one-third of the height of the wall, and is the same whatever be the slope; that in a plumb wall, if the height of the wall be three times the acting power of the earth, and base $\frac{2}{3}$ths of the height, there is an equilibrium against oversetting. The acting power in practice is one fourth of the weight of the triangle of the earth, with a slope of 45°, or one-half of the square of the wall.

He then shews, that retreats on the back of the wall may be made, so as to take off all acting power, and that a wall of 2 feet thick, and 30 high, battering $\frac{1}{45}$, with counterforts of 3 by 4, and 18 asunder, joined by two arches of 2 ft. thick, is abundantly strong. Such a wall be employed with success for one of the quays of the Saone; and it is evident, that the saving of masonry compared with the common construction is immense.

But in the walls of locks more must be attended to than the pressure of the earth alone. A film of water inserted between the back of the wall and the earth, will act hydrostatically against each of them, will counteract the aid which might be derived from friction, and if the lock be emptied in that state, may overset the wall inwards. But the hydrostatical pressure of the water within the lock can hardly do any harm, seeing the motion of the wall must be prevented by the resistance of the earth behind; hence, the utility of counterforts behind the wall, is mainly that of cutting off the communication between one portion of such a film of water and another, so that the action being confined to a smaller space is the less dangerous, as the wall also derives a kind of abutment from the counterforts. The upper part of the lock-wall, so far as the water rises and falls thereon, is (unless water be very abundant) usually made perpendicular, its thickness therefore must be so calculated as to resist the pressure of water of equal depth, and, taking the specific gravity of stone as $2\frac{1}{2}$ times that of water, this thickness will be the depth multiplied into 0·365, or a little more than $\frac{1}{3}$, and one half the depth will be sufficiently ample in any case.

The lower portion of the lock may be suited to the shape of the vessels which navigate through it, and therefore it will permit the wall to be made with a considerable batter, or slope to the front, by which means the point of conversion being farther removed from the centre of gravity of the wall, the stability will be considerably increased without an increase of materials; but it must be observed, that the point of conversion itself must be sufficiently secured. To prevent sliding, it ought to be inserted some way into the ground of the foundation. If built upon a timber platform, it ought to be provided with an abutment; and if upon piles, they ought to be driven in the direction of the thrust, which will be nearly that of the face of the wall. Now, as the opposite wall of the lock requires the same precautions, and its action is directly in face of the other, by joining the bottom of the walls by an inverted arch, we not only destroy the horizontal thrust, but also extend the foundation, which, in the case of soft ground, becomes of great importance. The inverted arch has been much employed in this situation by our late British engineers. On the Continent, we believe it is still the practice to rely on a platform of timber, or even a simple flat pavement, especially where the ground is firm. See the figures of the locks for the Canal of Burgundy, figs. 1 and 3 of the Plate.

In the timber countries, as Russia, America, and even Holland, where stone is scarce, there are locks of which not only the floor but even the sides are constructed of wood. In such cases, the thrust of the opposite sides are sometimes made to balance each other by cross pieces over the lock, placed between the upright posts which support the planking of the sides. Instances of this may be seen on the river Lea, but the practice is not certainly to be recommended.

This will tend to float the lock upwards like a ship, and unless the weight of the side-walls be sufficient to counteract this, the bottom or floor will give way, or be blown up, as is the technical phrase. The floatation of a timber floor will aid this operation, while the weight of an inverted arch will to a certain extent resist it. This forms one of the greatest objections to timber locks, and in them it is perhaps advisable that the dams of sheet piles should not be brought below the upper gates; but as all locks must at times be emptied for the purpose of repairs, &c. we have still the head of water of the lower pond, or ordinary depth of navigable water, to be resisted. The floor therefore must be carried a considerable way into the land, and thereby loaded by the adjoining earth; or, if built within a river, it must be kept down with stones, &c. laid over the cross beams projecting on each side. This is the construction of a lock on the Witigra canal. Or the floor and sides may be bolted to piles driven as firm as possible into the bottom, thereby as it were nailing the lock to the ground. The floatation of the lock and weight of the side-walls will counterbalance each other when the section of the masonry in the walls and bottom is two-thirds the area of the open space of the lock. Plate II. fig. 10. The average thickness of the walls, therefore, where there is no invert, would require to be one-third of the width of the lock. Where there is an invert, the thickness will be much less, but may be readily found from the above. Brick walls would of course require a greater thickness than those of stone; and here we may perceive the importance of those means by which the weight of the adjacent earth is made to rest upon the back of the wall, for we thereby obtain an additional counterpoise against the floatation without expense. Puddling behind the walls is therefore resorted to with great propriety. See fig. 11, Plate II.

It is needless in this place to be more minute in the calculation for the thickness of the walls; the principle may be easily understood and applied when wanted. Besides, with respect to locks, it is rather an extreme case, as they are rarely exposed to greater differences of pressure than the ordinary rise of the navigation. For tide-locks, and graving-docks, however, it is of high importance to guard against the hydrostatic pressure on the bottom; and serious accidents have taken place where it has not been sufficiently attended to. We proceed therefore with the practical construction of the lock itself. The site and dimensions of the lock being determined, the first object is the excavation of the lock-pit, or place for the foundation. In small canals and navigations carried above the level of the neighbouring valleys, this is seldom attended with any difficulty, the excavation being in most cases level free for drainage; but in great locks connected with rivers, lakes, or the sea, it is often necessary to go to a considerable expense; and in many cases, all the resources of hydraulic engineering are required to keep the excavation clear of water, or, when that is impracticable, to make a foundation independent of it.

The varieties of soil and situation render it impossible, in such a work as this, to give general rules for proceeding in all cases. We have already given some general principles under the article Bridge, which will, we believe, be most useful for the young engineer, even in constructing canals. Several good examples of lock making, that occurred in the construction of the Caledonian Canal, shall now be produced.

*Caledonian Canal.—Locks.*—The Caledonian Canal is not only constructed on an unusually large scale, but, in consequence of various localities in the situation of its works, it affords much practical information to the civil engineer. Some of the most important instances are in regard to the sea-lock at each extremity of the navigation; also that which is placed at the upper or south-western end of Loch Ness at Fort Augustus.

With regard to the lock at the north-east extremity.—The shore of Loch Beauly, where the canal was to be connected with the tideway at Clachnacarry, near Inverness, being very flat, it was necessary to carry the canal, by artificial embankments, above 400 yards from high water mark into the sea, in order to obtain 20 feet of water upon and without the lock sills, at high water of neap tides. But this shore consisting of soft mud, into which an iron rod was easily pressed to the depth of 55 feet, it became doubtful whether a sufficiently substantial cofferdam could be constructed of timber, and also if any platform could be made equal to support the weight of masonry unavoidable in a lock of 180 feet in length, 40 feet in clear width, having 20 feet of water, besides a rise of 8 feet. Upon duly considering all the circumstances, a new mode occurred to the conductors of that work, and that was, by uniting the two earthen banks which were projected from the shore, at the place where the site of the lock was fixed, so as to form a solid mound over all the space which the lock would occupy; and this was done for the purpose of squeezing out the water and consolidating the mud, by laying on a greater weight than the masonry of the lock: this was accordingly carried into effect. By the latter end of the year 1809, the mound was carried out to the necessary length, breadth, and height, and during its construction had sunk about 11 feet. A great quantity of stone was then laid upon the space the lock was to occupy, and levels taken to ascertain the precise height of the banks; in this state matters were suffered to remain for about six months, until August 1810, when, having found that no farther sinking had taken place, the excavation for the lock-pit was commenced in the before mentioned artificial mound; a chain-pump, worked by six horses, kept the pit dry when sunk to 15 feet in depth. At that time a steam-engine, of nine-horse power, was erected, by which the water was commanded, and the excavation of the lock-pit was completed in June 1811. Before getting down, to about 30 feet below the level of high water ordinary springs, it was necessary to penetrate into the compressed mud about 8 feet, and the small portions of water which filtrated through the surrounding mounds of earth (in which puddle walls had been carried up) was conducted in small gutters along the top of the compressed mud to the pump-well. As soon as the lock-pit had been excavated, rubble masonry, with lime mortar, was laid about two feet in thickness in the middle of the lock-chamber, and increasing to about 5 feet at each side; upon this the side-walls were founded, and brought up to the level of the top of the compressed mud, and then the inverted arch of squared masonry was put in, and the side-walls, counterforts, recesses, and wings, carried regularly up; the masonry of the bottom part was carried on by short lengths of about 6 yards at one time, in order to prevent the compressed mud again softening and being squeezed together in the open space. The above mentioned mud was found to be readily penetrated by piles, but when these were suffered to remain a few hours, no power could move them. The masonry of the lock was very successfully completed in August, 1812; the gates were afterwards put up, and the lock has been worked for several years. The whole is now in a very perfect state.

*Corpach Lock.*—The circumstances under which the lock at the south-western end of this navigation was constructed, differ greatly from what we have just described. It was found necessary to connect the canal with the tide-way in Loch Eil, at Corpach, on the north-west side of the rock, situated about 100 yards from high water; this rock was covered at three-fourths flood; and the lock was to be advanced so far into the sea, as to admit of the sill being laid upon the rock, where there should be 30 feet of water upon it at high water neap tides. For this purpose, water-tight mounds, faced with stone, were carried from the shore to beyond the extremity of the lock site. Between the extremity of these mounds, a wooden cofferdam was constructed. The clearing away the gravel, sand, and mud, the fixing the main piles firmly in the rock, and placing the wooden frames correctly in their proper places, were operations of considerable difficulty; but the success which attended a work of this magnitude and exposure, renders this mode deserving the attention of persons engaged in similar, or even inferior undertakings. Under the article BRIDGE foundations, we have minutely detailed every step of the process, and it would be an unnecessary repetition to introduce the description here; we therefore presume it will be sufficiently satisfactory to refer to that article. Only, it may be farther observed, that when the water had been excluded, and the rock excavated, no inverted arch was necessary.

*Fort Augustus Lock.*—The ground upon which the five connected locks at Fort Augustus were to be placed, consisting of coarse open gravel, and the lowermost of these requiring to be constructed so as to admit 20 feet of water upon the lower gate-sills at the lowest state of the water in Loch Ness; and the large river Oich, running upon the same sort of gravel, and close along the site of the lock, rendered it an arduous task to keep very large lock-pits clear of water; for the rise of these locks being only 8 feet, the foundations of the second and third locks were also considerably incommoded by water. This site for these locks being by much the most eligible for the navigation, it was absolutely necessary to endeavour to surmount these natural obstacles. The first step was, in 1814, to turn the whole of the river Oich to the northernmost side of a small island, and occupy part of the south channel by the locks. A trial-pit was next to be sunk; and, by means of a small steam-engine, of about six horse-power, it was carried to the depth of 18 feet; but here the water overpowered it. A pump-well was then begun, and an engine of 36 horse-power, which had previously been provided, was erected. It commenced working in August, 1816, and the excavation of the lock-pit was carried on with all possible energy. It was continued as long as the flood-waters of the Oich would permit—was again commenced as soon as the state of the river would admit, in 1817, and during that summer and autumn, the whole masonry of the lock, bottom, and wings, and the forebay, were got in; but, in order to command the water effectually, the engineer had, during that time, caused to be erected a third engine, of about nine horse-power, which happened also to be in readiness; and when the excavation was upwards of 25 feet below the surface of Loch Ness, and the whole of the gravel still coarse and open, the power of all the three engines was required. These lock-pits being sunk directly into a mass of gravel, no cofferdam could be of any service. Under the inverted arch and side walls of the lock, chamber, &c. rubble masonry of a sufficient thickness was constructed; but it was here laid upon, and mixed with, abundance of moss, and this was done in order to prevent any shifting sand from percolating. At the latter end of the working season of 1818, the whole masonry of the lowermost lock had been built, also the inverted arch, and 14 feet in height of the side walls of the second lock; and likewise the inverted arch, and 6 feet of the walls of the third lock; so that, except for the purpose of putting up the gates, there could be no farther occasion for employing the steam-engines at Fort Augustus, and every risk was at an end. In these three locks, there has, therefore, been afforded, cases of soft mud, hard rock, and very loose gravel, as foundations for very large locks. For their form and dimensions, see Plate II. figs. 5, 10, and 11.

The sheet piles, or plank piles heretofore alluded to, being of frequent use in hydraulic architecture, may be as well described in this place. They are sawn out of a thickness proportional to the strain they are intended to bear. The points are gradually sharpened so as to have a bevel or chamfer to one side only, so that in driving, each may be forced close against the preceding one; still farther to secure the seam or joint against the transpiration of water, it is not uncommon to groove the piles on one edge, and make a ridge or feather on the other to fit these grooves, so that the piles are, in driving, preserved in the same plane. Lastly, to save timber, the pile is frequently grooved on each side, and a slip or feather, which may be of harder wood, driven in between, so as to enter both grooves. The plank piles are preserved in position, by being spiked to sills, or horizontal beams of timber, extending in the line of the proposed sheet plank piling, and fastened to stout upright piles of baulk, placed at certain distances in the same line, called gauge piles.

In the construction of a lock, one of the earliest objects of attention is the platform on which the gates are to traverse. It is usually formed of timber. A stout floor of plank is spiked or tree-nailed down upon sills, or transverse beams, which are laid across the lock, and their extremities built into the walls. The scantling of the sills and plank are proportioned to the fatigue they have to undergo. In great locks, there are usually two rows of whole baulk in thickness, laid close together over the whole floor, carefully bedded in a mass of water-tight rubble masonry; and, when the foundation is doubtful, longitudinal ground sills are laid below, then resting, if need be, on piles driven to a proper depth. A row of grooved sheet piles is driven across the lock at the upper and lower end of this platform, and the floor is carefully caulked to prevent any transpiration of water.

On this platform the sill of the lower gates is placed; its construction is that of tie beam and two rafters, having the angle or curve of the lock gates; and as it has the thrust of the water to withstand, care must be taken to give it sufficient abutment. The platform of the upper gates is constructed in all respects similar to the lower. The sheet piling at the lower side is unnecessary; but care must be taken that the breast-wall or step of the lock be made water-tight, and carefully puddled upon the upper side. To prevent also its receiving any derangement from the blows of boats, &c. it is necessary to lay a wooden curb along the coping of this breast-wall.

In Ireland, timber has been sparingly used in the construction of locks; good stone and mortar are, in general, easily procured there. The platform for the gates is made of hewn stone. The sill is of hewn stone, set on edge, and usually two feet deep, supported on the lower side by a horizontal arch, which, at the upper gates, forms the coping of the breast of the lock; and, to resist blows from vessels, the key-stone of this arch is supported by two struts of horizontal flagging passing to the sides of the lock, or by a counter arch in the hewn pavement of the platform.

In constructing the side walls, a recess is made on each side, to permit the gates to fall back out of the way of vessels; and it is not uncommon to make those for the upper gates act as waste-weirs or overfalls, to discharge the superfluous water of the canal into the paddle holes. These paddle holes are conduits of stone or brick, usually of a circular form, and about 18 inches diameter, by which the water of the upper level is conveyed into the lock chamber. From the lock it is usually conveyed into the lower level through sluices or paddles formed in the gates, below the level of the lower water; but, in the upper gates, this is seldom practicable, for the breast of the lock being commonly higher than the lower level, a cascade would thereby be formed in the lock, which would be troublesome or dangerous to the vessels.

The conduits or paddle holes from each side are sometimes united at the back of the breast-wall, and discharge themselves through that into the lock. At other times they enter the lock separately in each side. In either case, the low level is preserved back to the place of entry, and the water is then permitted to fall down on a flat surface in the conduit, so as to break its progressive force as much as possible. The paddle itself is usually a square of cross planked wood, sliding up and down in a rabbeted frame of timber, fixed in the stone mouth of the conduit or paddle hole. The lateral pressure of the water makes it adhere closely to the frame, so that it is necessary not only to make it run with the grain of the wood, but also to have a considerable power to move it. This is done by a crank and pinion, working into a toothed rack, which is fixed on a bar or handle, rising from the paddle up to the top of the bank or gate. Sometimes screws are used instead of rack and pinion, and various other ingenious contrivances have been proposed, so as to make the paddle turn on an axis, either in its own plane, or at right angles thereto, like scouring gates, &c. One of the simplest modes we have seen of getting rid of the hydrostatic pressure and friction was proposed by Mr. John Duncombe, *viz.* to make the entrance or mouth of the paddle hole a horizontal circular opening, and stop it by an open cylinder ground to fit it, and rising of the same diameter to the surface, where it could be lifted by a lever or other means, like the waste pipe employed in some cisterns. The waste water of the canal would of course escape over the upper lip of the cylinder, and pass along the paddle holes as usual. Such a cylinder may be made of wood or iron.

The hollow quoins are upright circular grooves wrought in the side walls at the extremities of the sills; they serve as a hinge-place for the gate, the upright post of which that turns in them is named the heel of the gate; the opposite posts which abut against each other are called the head-posts. The heel-posts are retained in their places by a pivot or gudgeon at bottom, turning in a cup set in the stone, and sometimes the reverse, the cup being set in the heel-post. The upper part of the post is embraced by an iron strap or collar, which is carried back some way into the side wall, and firmly secured. The hollow quoins are commonly cut out of large scantlings of stone, or brick is moulded for the purpose, and cast-iron has also been employed on the Caledonian canal. The exterior portion of the lock above the upper and below the lower gates, are named the forebay and tailbay of the lock. The side walls are then made to splay away outwards to the usual breadth of the canal, so as to facilitate the entrance of vessels, and still farther to guide them; there are not unfrequently fender-beams, supported on piles, continued to some distance above and below the lock, and running into the bank on either side.

Strapping-posts are also used to check the way of the boats in entering the lock; and, in the passage-boats on the canals in Ireland, a broad shield of iron is placed on each side of the stem, and dropped under the quarter when the boat approaches a lock. It is readily hauled up again when the boat gets under way. It is the invention of Mr. Sisson Darling, late secretary to the Grand canal.

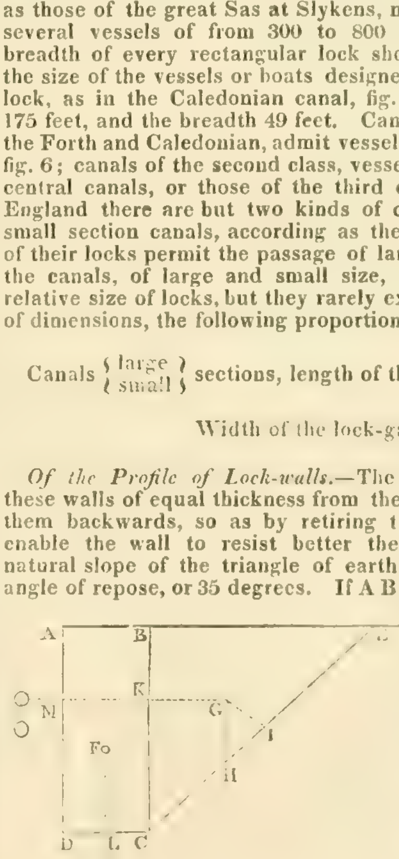
Lock-gates are framed usually of timber, though iron is also used in some of the small canals in England, and has lately been introduced in framing the large gates for the Caledonian canal. The head and heel-posts are connected by cross-beams or rails turned therein; the upper and lower bars are firmly attached by straps and bolts, and the whole planked over, usually in an oblique direction, by way of giving an additional stay to the framing. The head-posts must be brought truly to the angle of abutment. If of iron, they have a ribband of timber bolted thereon, to soften the blows they receive. The heels must be wrought to a circular form to fit the hollow quoin, into which the pressure of the water will force them home. The upper bar of the gate, in small canals, is usually continued a considerable way beyond the heel-post, and left as heavy as possible, or is loaded so as to form a counterpoise to the weight of the gate, and a lever for opening it. In great locks, capstans are employed to work chains, leading to the middle of the head-post on either side. Various other contrivances have been adopted for opening and shutting the gates of large locks. In Holland, a boom or spar is commonly attached to the head-post, and brought over a windlass on the lock-wall, a little above the gate; a rope is made fast to the end of the spar, and taking two or three turns on the windlass, the spar end is carried to the other end of the spar, which thus, by means of the windlass, is made either to open or shut the gate. At Antwerp, the French have employed a rack-bar of wrought iron nearly in the same way. These heavy gates have usually a roller or truck-wheel placed under the foot of the head-post, and running on a quadrantal railway of iron, to facilitate their motion. With the same view, also, attempts have been made to give floatation to heavy gates. In Sweden, some gates were made for the dock of Carlscrona, which were to sink into a deep recess, and rise when wanted by the admission of, and again pumping out of, a quantity of water, on the principle of the machine called the camel. At the dock of Monnikendam is the best, and we believe the oldest, boat-gate now in use. It has three parallel keels, which fit into grooves in the side walls, and, by admitting water, and extracting it again, it is made to sit down in its place, or float up so as to be removed when necessary; but though such vessels are peculiarly useful as stop-gates, or for docks, they are not well adapted to a constant or much frequented navigation.

Reservoirs.—The mode of supplying a canal plentifully with water, being essential to its prosperity, it generally employs the attention of the engineer, previous to determining the most advisable line. When it is necessary to establish a navigable communication between separate valleys or basins of country, and where a double lockage is unavoidable, the summit which divides them is generally too high to permit a regular supply of water being drawn directly from the streams on either side; or these streams are not unfrequently appropriated to the service of mills and manufactories, as in the cases of the Languedoc canal in France, the Grand Junction and many others in England, and the Forth and Clyde canal in Scotland. Under these circumstances, it becomes necessary to collect the flood-waters of the adjacent higher grounds into proper reservoirs, to be drawn off as occasion may require. The choosing a proper situation for a great reservoir, requires all the skill of the engineer. Much must always depend upon local circumstances, but some of the principal objects to be had in view, are, 1st. That the reservoir should be sufficiently low to collect the flood-waters from an ample surface of country. 2d. It should be so high as to enable all the water it contains to be drawn into the summit of the canal. 3d. It is desirable that the basin to be laid under water, should contract towards its lower extremity, so as to require a comparatively short embankment or head; and this head should be placed upon a substantial foundation. 4th. It is very important that the bottom and sides of the reservoir should be naturally impervious to water, otherwise much trouble and expense will be required to render them so, by artificial means. 5th. The dimensions of the embankment will be regulated by its height, and the nature of the materials with which it is to be constructed. It is, however, usual to assume the height of the top bank to be from three to four yards above top water when the reservoir is full; the breadth of the top to be five yards; the outside to slope at the rate of three horizontal to one perpendicular, and the inside slope at the rate of two horizontal for one perpendicular.—But these and similar erections must depend almost entirely upon the nature of the country, and the localities of situation, for which no specific rules can be given. Indeed, it is worthy of notice, and the consideration may lead to renewed exertions, that in the various branches of inland navigation in this country, the most valuable inventions and improvements have not originated so much in the depth of science, as in the application of practical skill, and ingenious experiment founded on a few general principles.

*Summary of our Observations on Canal Locks.*—The most natural form of a lock is that which approaches nearest to the figure of the boats which are to use it. The width must only be a little more than that of the boat, and it must be the same throughout, as the boat has to pass along the whole lock: and the length may only exceed that of the boat by a space sufficient to admit the opening and shutting of the gates. A long rectangle is the natural figure of a boat, and therefore of a lock: besides, it will consume less water than a circular dam in passing the boat; and may be filled and emptied in three minutes, as is the case with the locks of the Clyde and Forth canal in Scotland: moreover, the expense of construction, agreeably to this form, is less than any other shape. The locks of Languedoc canal, in France, are circular or oval, see figs. 1 and 3. Those of the canal of Brussels and others in Holland, are rectagonal, but of such extensive chambers as to admit several vessels at once, which is attended with waste of water, and great delay in the passage of the boats. Tide locks, as those of the great Sas at Slykens, near Ostend, may admit several vessels of from 300 to 800 tons. The length and breadth of every rectangular lock should be proportioned to the size of the vessels or boats designed to pass through this lock, as in the Caledonian canal, fig. 5, where the length is 175 feet, and the breadth 49 feet. Canals of the first order, as the Forth and Caledonian, admit vessels of 19 and 39 feet beam, fig. 6; canals of the second class, vessels of 14 feet beam; and central canals, or those of the third class, 7 feet beam. In England there are but two kinds of canals, called large and small section canals, according as their breadth and the size of their locks permit the passage of large or small boats. All the canals, of large and small size, have not a determined relative size of locks, but they rarely exceed, in their difference of dimensions, the following proportions:

| | Sections. |
|---|---|
| Canals { large / small } sections, length of the locks .... | 75 . 6<br>75 . 6 |
| Width of the lock-gates ........ | 15 . 1<br>8 . 6 |

*Of the Profile of Lock-walls.*—The late Mr. Jessop made these walls of equal thickness from the base upwards, leaning them backwards, so as by retiring the centre of gravity, to enable the wall to resist better the lateral pressure. The natural slope of the triangle of earth is chamfered off at the angle of repose, or 35 degrees. If A B C D, in the figure, be the erection of the wall, and B C the moveable part of the earth supported by the wall; then taking G the centre of gravity of the earth, and F that of the wall, and drawing the perpendiculars G H, G I, G K, and F L; G H represents the direction of the gravity of the earth, G I the direction of the



support given by the firm inclined plane C E, and G K of the horizontal thrust against the wall A B C D. The back of the wall is supposed to be smooth, and of course only to be acted upon perpendicularly; and the wall itself to be a solid mass, which can only be turned over the front angle of its base, or toe of the wall D. It resists this by its own weight, which may be supposed to be concentrated in the centre of gravity, and to act in the vertical line F L W. If W represent the *weight* of the wall, and P the horizontal thrust of the earth, M D and D L will be the two arms of a lever by which these forces are kept in equilibrio.

Now we know that M D or K C are two-thirds of B C; that the weight of earth is proportional to the area B C E, that is, to one-half of B C × B E; and that this weight in G H is to the thrust in G K as E B is to B C. The thrust is, therefore, equal to $\frac{1}{2}$ B C$^2$; and multiplying by its distance M D from the fulcrum D, that is, by $\frac{2}{3}$ B C, we have its oversetting force equal to $\frac{1}{3}$ B C$^3$. Consequently, the oversetting force of earth supported by walls of equal thickness is as the cube of the height. Now for the counter resistance of the wall, it is evident that its weight will be as the area A B C D, which in a rectangular wall is B C × C D; and in that case also we will have the distance L D from the fulcrum $= \frac{1}{2}$ D C, or that the resistance is $\frac{1}{2}$ B C × C D$^2$, making this force equal to the former, or $\frac{1}{3}$ B C$^3$, we find $CD = BC\sqrt{\frac{2}{3}} = \cdot 8165 \times BC$.

The breadth of an upright retaining wall, must therefore be proportional to the height, and, to be of equal specific gravity with the stuff, must be upwards of four-fifths of the height. This, however, is different from what is found sufficient in practice. A brick wall, to support earth, is made four-sevenths of its height; of a stone wall $\frac{21}{44}$, or about half the height, when the earth is supposed to act not parallel to the horizon, but in lines parallel to the slope E C. The wall cannot fall on the side next the earth, therefore, by making it lean backwards, not only is the triangle of earth or acting power diminished, but also the wall itself, by having its centre of gravity removed further from the point of conversion at the toe, is the better enabled to resist the thrust. It batters in the form of a mere pavement over the slope of earth; all that is necessary, being to secure the foot from sinking or sliding forwards into the canal.

Coehorn, adopting the opinions of some old German engineers, and designing walls for the soil of Holland, gives them three feet of thickness in front, and leaving nearly as much behind, supported by long and thin counterforts, that are connected together by two rows of arches one over the other, and also by two walls arched horizontally against the earth.

Gauthey, a French engineer, who constructed the canal of Charalois, shews, by experiments made with sand and shot against a smooth plane, that the pressure acts at the centre of gravity, or one-third of the height of the wall, and is the same whatever be the slope; that in a plumb wall, if the weight of the wall be three times the acting power of the earth, and base two-ninths of the height, there is an equilibrium against oversetting. The acting power in practice, is one-fourth of the weight of the triangle of the earth, with a slope of 45°, or one-half of the square of the wall. He then shews that retreats may be made in the back of the wall so as to take off all acting power, and that a wall 2 feet thick and 30 feet high, battering $\frac{1}{45}$, with counterforts of 3 by 4, and 18 asunder, joined by two arches of 2 feet thick, is abundantly strong. Such a wall he employed with admirable success, for one of the quays of the Saone; and it is evident, that the saving of masonry, compared with the common construction, is immense. Brick on bed, with a sufficient batter, and corbels made by laying one brick endways in the wall, so that half of it projects behind, will create a sufficient friction to allow 20 courses to be piled against loose sand without derangement. In locks, allowing for the film of water that may insinuate itself between the masonry and the earth, taking the specific gravity of stone as $2\frac{1}{2}$ times that of water, the proper thickness will be the depth multiplied by 0.365 or little more than $\frac{1}{3}$, and one-half the depth will be sufficiently ample in any case. The upper part of the wall is usually perpendicular, the lower suited to the shape of the vessels, or rounded off.

The walls of the quays of one of the basins of the Fazeley canal, are covered with plates of cast-iron, joined by tenons and mortises fixed to the masonry with screw bolts; and in this canal we descend 246 feet by 38 locks in a space of eight miles. Mr. Telford, in the fine construction of the aqueduct of Pont-y-Cyssyltan,* 126 feet above the level of the river, and 1010 feet in length, erected nineteen metal arches on eighteen piles of brick, to two abutments of stone; above these arches of the aqueduct of Chirk, he built side walls with brick in the usual manner, but with stone coating. Between these walls he laid down large plates of cast-iron, for the bottom of the canal, carefully clamped, then fastened with iron pins, screwed and caulked in the joints: these plates serve at the same time as continued holdfasts, in order to prevent the side walls from being thrown downwards by the pressure of the fluid. To give the structure a greater resistance against the pressure of the water, the sides of the canal are composed of strong plates of wrought-iron, not cut straight, but so formed as if they were a continuation of the lines presented by the solid parts of the ribs of the bridge; and the plates which join the parts of one arch with those of another, are wider at the bottom than at the top, which produces the same effect as that of buttresses supporting a wall. The lower portion of the lock may be suited, we said, to the shape of the vessels which navigate it, and therefore it will allow the wall to be made with a considerable batter, or slope, to the front, by which means the point of conversion being farther removed from the centre of gravity of the wall, the stability will be considerably increased without an increase of materials; the point of conversion, to be sufficiently secured to prevent sliding, ought to be inserted some way into the ground of the foundation.

There is yet another principle by which the profile of the lock-wall must be regulated; the transpiration of the waters from the upper pond to the lower, beneath, or by the side of the lock, must be prevented. This is effected by rows of sheet or plank piles, (as in fig. 1,) carried across the site of the lock, and driven a considerable way under its foundation. The points are champered off, so that in driving each may be forced close against the preceding one: still further to secure the seam joint against the transpiration of water, it is not uncommon to groove the piles (as in fig. 2,) on one edge, and make a ridge on the other; or to groove each side, and slip a feather of a different wood into these grooves. The plank piles are again fastened to stout horizontal beams of timber, extending in the line of the proposed sheet plank piling, and fastened to stout upright piles of balk, placed at certain distances in the same line, and called gauge piles. The film of water that is filtred under the floor of the lock being connected with the upper pond, acts upwards by a pressure equivalent to the head of water, or difference between the waters above and within the lock, and unless the weight of the side walls be sufficient to counteract this, the bottom of the floor will give way, and be blown up. The floatation of a timber floor, and the weight of an inverted arch, will, in some measure, counteract this, when the section of the masonry in the walls and bottom is two-thirds the area of the open space of the lock. We may assume the specific gravity

*Fig.* 1.

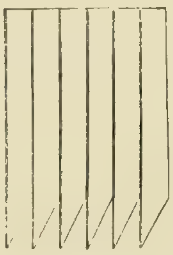
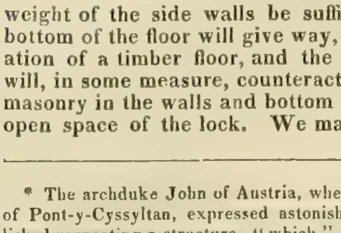


*Fig.* 2.



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* The archduke John of Austria, when viewing the magnificent aqueduct of Pont-y-Cyssyltan, expressed astonishment that nothing had been published respecting a structure, "which," said the prince, "in France would have produced three folio volumes!" What a fine compliment on the merit and modesty of Mr. Telford?

# NAVIGATION, INLAND.

## THE THEORY & PRACTICE OF LOCKS, GATES, &c

Fig 1. Single Lock on LANGUEDOC CANAL.

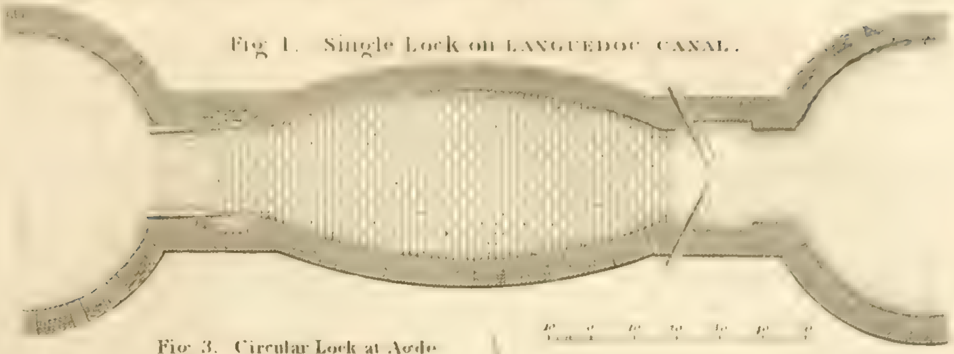


Fig 2

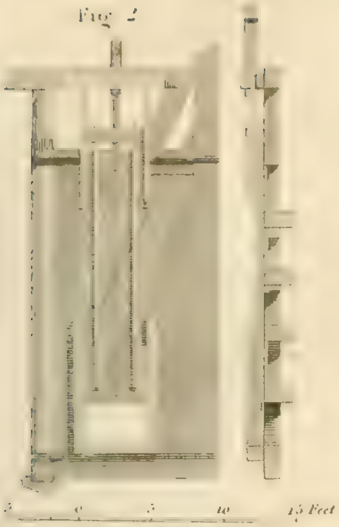


Fig 3. Circular Lock at Agde

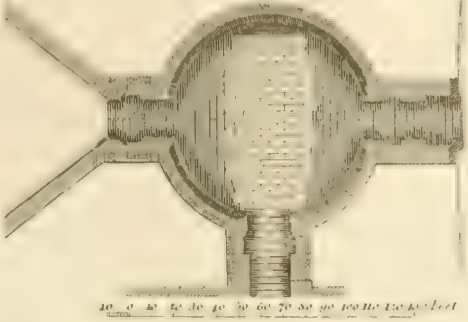


Fig 4

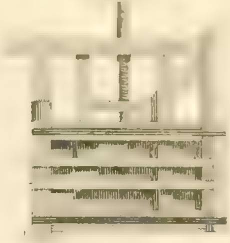
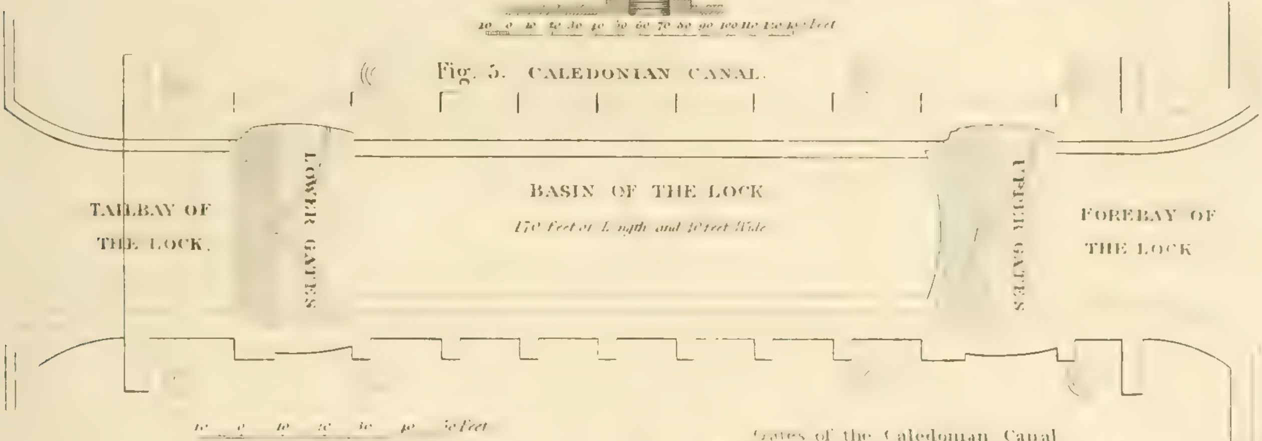


Fig. 5. CALEDONIAN CANAL.



Gates of the Caledonian Canal

Fig 7. Upper

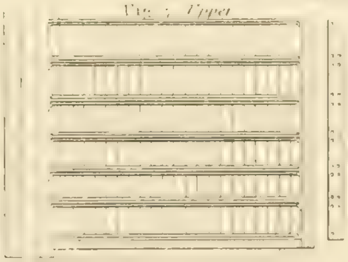
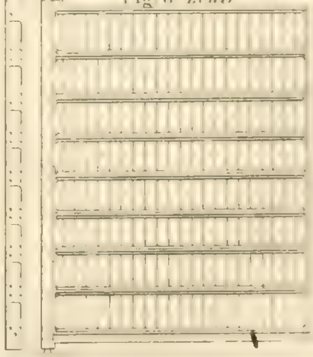


Fig 8. Lower



Section of the Canal

Fig 6

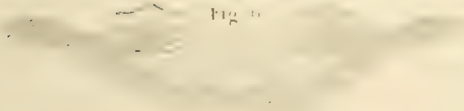
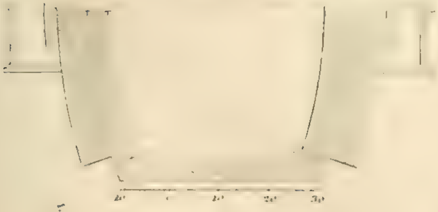


Fig 9.

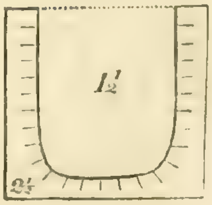
Fig 10. MASON WORK OF LOCKS Fig 11.



Plan & Details of the Caledonian Canal

of the building, (see fig. 3,) 2½ times that of the water: it will therefore compensate for an opening of 1½ times its bulk, when the whole is immersed: when there is no invert, the average thickness of the walls is one-third the width of the lock; when there is an invert, they may be much less. In great locks connected with rivers, those moving roads and feeders of canals, or connected with lakes or the sea, all the resources of hydraulic engineering are put in requisition.

*Fig.* 3.



In constructing the side walls of locks, a recess is made, to permit the gates to fall back out of the way of vessels, as is shewn in the canal of Languedoc, and the Caledonian canal, figs. 1 and 5, Plate of Locks; and it is not uncommon to make those for the upper gates act as waste weirs, fig. 7, Plate of Locks, or overfalls, to discharge the superfluous water of the canal into the paddle-holes, or conduits of stone or brick 18 inches diameter, by which the water of the upper level is conveyed into the lock chamber. From the lock it is usually conveyed into the lower level through sluices formed in the gates, fig. 2, below the level of the low water. The paddle is moved by a crank and pinion working into a toothed rack, see fig. 2. The exterior portion of the lock, above the upper and below the lower gates, is named the forebay and tailbay of the lock, in the Caledonian canal. The lock gates are usually framed of timber, figs. 2 and 4, though, I believe, iron is greatly used in the small canals in England. I know it was used in framing the large gates of the Caledonian canal, (see the Plate Locks, Gates, &c. figs. 7 and 8,) and in the New Graving Dock at Dundee.

For the purpose of securing water in the locks, solid plungers in parallel chambers, raising and depressing boats in caissons or frames, by chains passing over large wheels, and by means of working air vessels, have been projected and tried in model, but seldom in practice. Inclined planes connecting different canal levels have existed in China from time immemorial, and they have been long usefully employed in England, as a species of rail road.

Waste weirs are either constructed across rivers, to force the water from them into the conducting feeders, or immediately into the canal itself, or they permit the surplus water to pass off the canal. It is also requisite to have wastes adjacent to locks, to convey water from upper to lower levels, without passing through the locks. To canals belong also aqueducts, bridges, oblique arches, or skewed bridges, stop-gates, and let-offs. *See* Locks and Docks.

**NAVY**, implies in general any fleet or assemblage of ships of war, which belong to a kingdom or state.

Of the arts and professions which attract notice, none is more astonishing and marvellous than navigation in its present state, comparing the small craft of antiquity to a majestic first-rate, containing 1000 men, with their provisions, drink, furniture, apparel, and other necessaries for many months, besides 100 pieces of heavy ordnance, and bearing all this vast apparatus safely to the most distant shores. How great is the disparity? 8000 lbs. of provisions are required daily in such a ship. Suppose her fitted out for three months, we shall find her laden with 723,000 lbs. of provisions. A cannon, if called a forty-two pounder, weighs about 6,100 lb, if made of brass; and about 5,500 lbs. if made of iron; there are twenty-eight or thirty of these on board a ship of 100 guns; their weight, exclusive of their carriages, amounts to 183,000 lbs. On the second deck, thirty twenty-four pounders; each weighing about 5,100 lbs. and therefore altogether, 153,000 lbs.; and the weight of twenty-eight twelve pounders on the lower deck, amounts to about 75,400 lb.; fourteen six-pounders on the upper deck, to 26,000 lb. and on the round tops, there are three-pounders and swivels of smaller size. The complete charge of a forty-two-pounder weighs about 64 lb., and upwards of 100 charges are required for each gun. All this amounts nearly to the same weight as the guns themselves. Every ship must be provided against exigencies, with two sets of sails, cables, cordage, and tacklings: the stores, likewise, consisting of planks, pitch, and tow: the small arms, bayonets, swords, and pistols, make no inconsiderable load, to which we must finally add the weight of the crew; so that one of those large ships carries at least 2000 tons burden, and at the same time is steered and governed with as much ease as the smallest skiff on the Thames.

The British naval force, during the late war, (on the 1st of January 1813,) was as follows:- at sea 79 ships of the line; nine from 50 to 44 guns; 122 frigates; 77 sloops and yachts for bombs, &c.; 161 brigs; 54 cutters; 52 schooners, &c. In port and fitting, 39 of the line; 11 from 50 to 44 guns; 29 frigates, hospital ships, prison ships, &c. 28 of the line; two from 50 to 44; two frigates; one yacht. Ordinary and repairing for service, 77 of the line; 10 from 50 to 44 guns; 70 frigates; 37 sloops: 3 bombs, 11 brigs; 1 cutter; 2 schooners. Building, 29 of the line; four from 50 to 44 guns; 15 frigates; 5 sloops, &c. 3 brigs.

A fleet of ships of war is generally divided into three divisions; and commanded by admirals, vice-admirals, or rear-admirals, of the white, blue, and red flags.

A squadron of ships is a division or part of a fleet commanded by a commodore, or by a rear or vice-admiral. The number that forms a squadron is not fixed, for a small number in a body and under one commander may make a squadron. If the ships are numerous they are sometimes divided into three squadrons, and each squadron may be again divided into three divisions.

A frigate is a light-built fast sailing ship, having commonly two decks, whence that called a light frigate is a frigate with only one deck. These vessels mount from 20 to 44 guns, and make excellent cruisers.

Hulks are old ships cut down to the gun-deck, and fitted with a large wheel for careening. Their gun-decks are from 113 to 150 feet long, and from thirty to forty feet broad; they will carry from 400 to 500 tons. Hulks are also employed at Woolwich, Portsmouth, Sheerness, &c. to receive convicts under sentence of transportation; the vessels are moored at such a distance from shore, as precludes the possibility of the men's escape; and the convicts are taken daily on shore to work, under a strong guard, at pile-driving, barbour cleansing, and other employments in the several public departments.

A hoy is a small vessel or bark, whose yards are not across nor the sails square, like those of ships, but the sails like a mizzen, so that she can sail nearer the wind than a vessel with cross sails can do.

Sloops are appendages to men of war, about 60 tons burden, and carrying 30 men. They are light vessels, with only a small main-mast, fore-mast, and lug-sails to haul up and let down, on occasion, and are commonly fast sailers.

Smacks are small vessels with one mast; they sometimes are employed as tenders on a man of war: they are also used for fishing upon the coasts.

Store ships are generally ships of from 300 to 600 tons; they carry ordnance and military stores to the out-ports, or to an army when abroad.

A yacht, a vessel for the conveyance of passengers, is also sometimes adorned for regal use. It is furnished with masts and sails, has one deck, carrying from four to twelve guns with from twenty to forty men; burden from thirty to 160 tons. They are used for running, and making pleasure excursions.

A galley is a low-built Mediterranean vessel, having oars and sails. Galleys have usually twenty-five or thirty benches of oars on each side, and four or five galley slaves on each bench. The galley usually carries a large gun, two bastard pieces, and two small pieces. It is from twenty to twenty-two fathoms long, three broad, and one deep, and has two masts, viz. a main-mast, and a fore-mast, which may be struck or lowered at pleasure.

*Naval Distinctions in Rank.*—The Lord High Admiral of England is an officer of great trust; the king is nominally Lord High Admiral, while the duties of the office are executed by commission, called the Board of Admiralty, consisting of five commissioners denominated Lords of the Admiralty, one of whom, as resident, is called First Lord.

The Board of Admiralty takes cognizance of every thing transacted at sea, the management of all maritime affairs, the direction of the navy, and both civil and criminal offences committed on the high seas. Under this court is also a court merchant, or court of equity, where all differences between merchants are decided according to the rules of the civil law. This court is held three or four times a year at the Old Bailey, and one of the judges generally acts as the Lord Admiral's deputy.

An Admiral is a great officer, who has the government of a navy, and the hearing of all maritime causes. In our navy, besides the admiral in chief, there are the Vice-admiral, who commands the second squadron; and the Rear-admiral, who commands the third division. The admiral carries his flag at the main; the vice-admiral, at the fore-top mast head; and the rear-admiral at the mizzen. The admiral ranks with generals in the army.

A Captain commands a ship of the line of battle, or a frigate carrying twenty or more guns. He is not only answerable for any bad conduct of the military government and equipment of the ship which he commands, but also for any neglect of duty.

A Lieutenant, an officer next in rank and power to a captain, in whose absence he commands, musters the men at quarters; visits the ship during the night watches; exercises the men in the use of small arms. First-rates have six lieutenants; a sixth-rate has only one.

Midshipmen, generally youths appointed by the captain of the ship, second the orders of the superior officers, and assist in all duties on board or ashore. In a first-rate there are twenty-four of these, in inferior rates from eight to four.

A Pilot conducts the ship into harbour through intricate channels. This is properly a coasting pilot; one for the high seas can use the quadrant, take observations, and steer a ship from port to port.

The Purser receives the victuals, takes care they be good, and regularly served out to the ship's company. According to the purser's books the men receive their pay. The Steward acts under the purser.

The Victualler furnishes the ship with provision and stores. The Clerk sees that nothing be wasted, and keeps a journal of the loading of a merchant ship, &c. the bargains, purchases, and sales the ship makes from its departure; the consumption of provisions; and every thing relating to the expense of the voyage. In small vessels the master or mate is also clerk. A mate is the second in subordination, as a master's mate.

The Surgeon and Chaplain resemble the same officers in the army.

Marines have nothing to do in working the ship, but defend it in war, and attack the enemy when fighting. There is generally a company aboard each ship, about forty in number, under a captain and two lieutenants. The present establishment of marines amount to more than 30,000. Their principal stations are at Chatham, Woolwich, and Portsmouth. In a sea-fight their small arms are of very great advantage in scouring the decks of the enemy, and when they have been long enough at sea, they must be infinitely preferable to seamen, if the enemy attempts to board, by raising a battalion with their fixed bayonets.

Officers of the navy are, the treasurer, who receives monies out of the exchequer to pay charges of the navy. The controller, who attends and controls all payments of wages, knows all the rates of stores, examines and audits all accounts. The surveyor knows the state of all stores, sees all wants supplied, estimates repairs, &c. and at the end of each voyage, audits and states all accounts. The clerk of the acts records all orders, contracts, bills, warrants, &c.

Navy bills, or victualling bills, are orders for the payment of money, issued by the commissioners of the navy on the treasury of the navy, in payment for stores, &c. furnished by contract for the use of his majesty's dock yards, and the navy. These bills, since 1796, are negotiated like bills of exchange, payable at ninety days after date, and bearing interest at 3½d. per cent. per diem. The privileges conferred on sailors are much the same as on soldiers, with regard to relief, when maimed, wounded, or superannuated. Greenwich Hospital receives such seamen as are disabled from further service, and provides for the widows and children of such as are slain.

The royal Navy of Great Britain is conducted under the direction of Lords of the Admiralty, by the following principal officers, who are commissioners, and compose the board for managing the business thereof. 1. Comptroller of the navy, who attends and controls the payment of all wages, as to know the rates of stores, &c. 2. Supervisor of the navy, who is to know the state of all stores, to supply what is wanting, to estimate repairs, charge boatswains, &c. with the stores they receive, &c. There have been generally two joint surveyors. 3. Clerk of the acts, whose business is to record all orders, contracts, bills, warrants, &c. 4. Comptroller of the treasurer's accounts. 5. Comptroller of the victualling accounts. 6. Comptroller of the store-keeper's accounts. 7. One extra-commissioner. The annual appointment of each commissioner is 500l. In time of war, or great naval exertion, there are other extra-commissioners, and commissioners are then appointed to reside at some of the principal yards abroad. The treasurer of the navy has an appointment of 2000 per annum. His business is to receive money out of the exchequer, and to pay all the charges of the navy by warrant from the principal officers. Each of these commissioners and officers has a number of subordinate clerks with various salaries.

Navy, is also used to denote the collective body of officers employed in his majesty's sea service.

Navy *Board*, the commissioners of the navy collectively considered.

Navy *Office*, the office where the accounts of the navy are kept.

NAZARENES, a term originally applied to Christians in general, but afterwards to the sect who blended the institutions of the Mosaic law with those of the gospel.

NAZARITES, among the Jews, persons dedicated to the observation of Nazariteship, either for only a short time, or all their lives. All that we find peculiar in the latter, is, that they were to abstain from wine and all intoxicating liquors, and never to shave or cut off the hair of their heads. The first sort of Nazarites were moreover to avoid all defilement; and if they chanced to contract any pollution before the term was expired, they were obliged to begin afresh.

NE ADMITTAS, in Law, a writ directed to the bishop, at the suit of one that is patron of a church, where on a *quare impedit*, &c. depending, he is doubtful that the bishop will collate his clerk, or admit the other's clerk, during the suit between them.

NEAP Tides, are those which happen when the moon is nearly at the second and fourth quarters: the neap-tides are low tides, in respect to their opposites, the spring tides.

NEAPED, the situation of a ship which is left aground on the height of a spring tide, so that she cannot be floated off till the return of the next spring.

NEBULA, a luminous part of the heavens, called the Milky Way, which consists of myriads of fixed stars too small to be seen by the naked eye, and visible only by the best glasses. Some of these nebulæ consist of clusters of telescopic stars; others appear as luminous spots of different forms. Each nebula is thought to be composed of a number of suns, and each sun is probably destined to give light to a system of worlds. There are also nebulous stars, that is, stars surrounded with a faint luminous atmosphere.

NECESSITY, whatever is done by a necessary cause, or a power that is irresistible, in which sense it stands opposed to freedom. The law charges no man with default where the act is compulsory, and not voluntary, and where there are not a consent and election; and therefore if either there is an impossibility for a man to do otherwise, or so great a perturbation of the judgment and reason as in presumption of law man's nature cannot overcome, such necessity carries a privilege in itself.

Necessity, *Philosophical*, maintains that the volitions and actions of intellectual agents are produced by causes equally deciding and resistless as those which are admitted to actuate the material system of the universe. Wherever the sun shines, or the rain descends, it is impossible to conceive, that in situations precisely similar to those which immediately precede these events, the ray should be withheld, or the cloud should remain suspended in the atmosphere. The diffused splendour, and the falling moisture, are universally allowed to be in such situations invariably and inevitably the results. The doctrine of necessity extends to the mind what is thus obvious and uncontradicted with respect to matter, and insists on the absolute and uncontrollable influence of motives upon the human will and conduct. It asserts, that the determinations and actions of every individual flow, with unfailing precision and resistless operation, from the circumstances, motives, or states of mind by which they are preceded; and that, in the whole series of his existence, no specific feeling, thought, or act, could have been different from what it really was, these previous circumstances continuing the same. In the consideration of this subject, it is important not to confound necessity with compulsion, as the latter implies that the choice of the mind is effected with reluctance, and in consequence of the exercise of force upon inclination; whereas, whether the conclusion be formed with the full concurrence of the affections, or after a conflicting estimate, which leaves reason completely triumphant over inclination; the mind is equally impelled by some controlling energy, and equally necessitated to the determination it adopts. It is of consequence also to the illustration of the subject, fully to comprehend the meaning of the term motive, which, it is to be remembered, comprehends both the bias of the mind and the end in view, and includes every thing that moves or influences the mind, and excites it to a choice or determination.

**NECROMANCY**, a pretended divination by raising the dead and extorting answers from them.

*Bolt Rope* **Needle**, a large needle with a triangular point, used to sew the bolt-rope upon the sails.

*Sail* **Needles**, are needles used for sewing the seams of sails.

**NE EXEAT REGNO**, is a writ to restrain a person from going out of the kingdom.

**NEGATIVE Quantities**, are those quantities which are preceded or effected with the negative sign.

**Negative** *Sign*, in Algebra, is that character, or symbol, which denotes subtraction, being a short line preceding the quantity to be subtracted, and is read *minus*; thus $a-b$ denotes that the quantity $b$ is to be taken from the quantity $a$, and is read *a minus b*, like signs produce *plus*, and unlike signs *minus*, hence $-a \times -b = +a\,b$. The introduction of this character has given rise to various controversies, with regard to the legality or illegality of certain conclusions depending upon it; some maintaining, that as a negative quantity is in itself totally imaginary, it ought not to be introduced into a science, the excellency of which depends upon the rigour and certainty of its conclusions; while others running into the opposite extreme, have endeavoured to illustrate what will not admit of illustration; and thus, like other zealots, have been the greatest enemies of the cause they were so anxious to defend.

It is vain to attempt to define what can have no possible existence; a quantity less than nothing is totally incomprehensible; and to illustrate it, by reference to a debtor and creditor account, to say the least of it, says Barrow, is highly derogatory to this most extensive and comprehensive science.

**NEGRO**, a name given to a variety of the human species, who are entirely black, and are found in the torrid zone, especially in that part of Africa which lies between the tropics.

**NEPA**, *Water-scorpion*, a genus of insects of the order hemiptera, of which there are fourteen species, inhabiting stagnant waters, and preying on the smaller water insects, &c.

**NEPENTHES**, a genus of the diœcia syngenesia class and order, an herbaceous plant of Ceylon. The leaves are alternate, partly embracing the stem at their base, and terminated by tendrils, each of which supports a deep, membranous urn, of an oblong shape, and closed by a little valve like the lid of a box. In the morning the lid is closed, but it opens during the heat of the day, and a portion of the water evaporates; this is replenished in the night, and each morning the vessel is full, and the lid shut.

**NEPETA Calamintha.** *Field Calaminth. The Leaves.* This is a low plant growing wild about hedges and highways, and in dry sandy soils. The leaves have a quick warm taste, and smell strongly of pennyroyal: as medicines, they differ little otherwise from spearmint, than in being somewhat hotter and of a less pleasant odour; which last circumstance has procured calamint the preference in hysteric cases.

**Nepeta Cataria.** *Nep* or *Catmint. The Leaves.*—This is a moderately aromatic plant, of a strong smell, not ill resembling a mixture of mint and pennyroyal; it is also recommended in hysteric cases.

**NEPHRITE**, in Mineralogy, a species of the talc genus; it is also called *jade* or *jade-stone*, and was formerly celebrated for its medicinal virtues. It is of a dark leek-green colour, verging to blue, and is found in Egypt, China, America, the islands in the Pacific ocean, and in the Siberian mountains, sometimes adhering to rocks, and sometimes in detached round pieces. It is highly prized by the Hindoos and Chinese, by whom it is made into talismans and idols, and by the Turks, who form it into sword and dagger handles.

**NEPHRITIC**, something that relates to the kidneys.

**Nephritic Wood**, a wood of very dense and compact texture, and of a fine grain, brought from New Spain, in small blocks, in its natural state, and covered with its bark. It is to be chosen of a pale colour, sound and firm, and such as has not lost its acrid taste. This wood is a very good diuretic, and it is said to be of great use with the Indians in all diseases of the kidneys and bladder. It is also commended in fevers and obstructions of the viscera. Among the Indians it is used only with an infusion in cold water.

**NEPTUNIAN THEORY**, in Geology, endeavours to account for the various geological phenomena, on the supposition that the matter of which the exterior part of the earth is composed was once in a state of watery solution. Its chief supporter is Werner. It is opposed to the Plutonic or Vulcanic theory, which supposes the phenomena to have resulted from the matter of the earth having been in a state of fusion by fire; of this theory Dr. Hutton is the principal champion. That the surface of our globe was once in a fluid state, is established by very ample evidence. In the greater number of the strata of the earth, in the most elevated, as well as at the greatest depths, substances are found in a crystallized state; and even many of these strata have marks of crystallization in their entire structure. Crystallization is the arrangement of particles in a regular determinate form; and it necessarily implies a previous state of fluidity, which would allow these particles to arrange themselves in positions necessary to produce these forms. Many of the more solid strata contain in their substance remains or impressions of animals and vegetables: and it is obvious that, to admit of the introduction of such substances, they must at one time have been, if not in a perfectly fluid, at least in a soft or yielding state. In addition to this, the general disposition of the materials of the globe, so far as has been explored, must have arisen from fluidity, as this only could have arranged them in beds or strata, parallel to each other, and preserving that parallelism to a great extent. These appearances are not partial, but extend to the whole surface of the earth, and prove beyond a doubt its former fluidity. There are only two ways by which that fluidity can be supposed to have taken place: either the solid matter must have been fused by the action of heat, or it must have been dissolved in some fluid. These are the primary principles upon which the geological theories have been formed, under different modifications.

**NEREIS**, in Natural History, a genus of the vermes mollusca class and order. There are about thirty species, in separate divisions, found in most seas, and are highly phosphorous, giving a lucid splendour to the waves in the evening.

**NERVES**, cylindrical whitish parts, usually fibrose in their structure; or composed of clusters of filaments, arising from the brain, or rather from its medulla oblongata within the skull, and from the spinal marrow, and running from thence to every part of the body.

**NET**, a device for catching fish and fowl. The making of nets is very easy. All the necessary tools are wooden needles of different sizes, some round, and others flat: a pair of round-pointed and flat scissars, and a wheel to wind off the thread. The strength of the packthread, and the size of the meshes, must be according to the fishes or birds to be taken. The natural colour of the thread in many cases to be altered. The most usual colour is the russet, obtained by plunging the net into a tanner's pit, and letting it lie there till it be sufficiently tinged. A green colour is given by chopping some green wheat and boiling it in water, and then soaking the net in the tincture. A yellow colour is given in the same manner with the decoction of celandine, which gives a pale straw colour.

NETTING, a sort of fence, formed of an assemblage of ropes fastened across each other, so as to leave uniform intervals between. These are usually stretched along the upper part of a ship's quarter, to contain some of the seamen's hammocks, and secured in this position by rails and stanchions. Nettings are also used for containing the fore and main top-mast stay-sails when stowed.

*Boarding* NETTING, a netting extending fore and aft from the gunwale to a proper height up the rigging. Its use is, to prevent an enemy jumping aboard, on to the decks, in an engagement, &c.

NET WORK, BUCHANAN'S MACHINE FOR. WEAVING.—The object of this newly invented machine, is to weave, expeditiously and without knots, any kind of net-work, and to allow the holes or meshes of the net-work to be enlarged or diminished according to the option of the operator.

Alexander Buchanan of Paisley, the inventor, adds another instance to the number of proofs that he has already given of his inventive genius, and ardent desire to improve the arts and manufactures of his native country. The machine in question consists of the following parts:—A B C D, fig. 1, represents a wooden stand upon which an iron frame, E F G H, is supported at each corner. In this frame there are seven wheels, 1, 2, 3, 4, 5, 6, 7, that pitch into each other. *i, k, l, m*, are continuations of the axis of the wheels numbered 1, 2, 5, 7. Upon the ends of the axis thus continued, circular pieces of wood, I, K, L, M, are fixed, a perspective view of which is given at fig. 2. The other wheels, 2, 4, 6, are introduced in order that when the machine is put in motion, those numbered 1, 3, 5, 7, may turn in the same direction, as it is necessary that the parts of the machine attached to the axis of these should do so. Into each of the circular woods, four grooves are cut, which allow the shuttles, *a, b, c, d, e, f, g, h*, to slide out and in at the circumferences of the circular woods, but prevent them from coming out when drawn in a direction towards R. The shuttles, one of which is represented at fig. 3, consist of three parts. A, fig. 3, is that part which slides into the grooves B, the projecting part, and C, that which holds the pirn or bobbin. The use of the grooves is to allow the shuttles to be moved from one circular wood to another in crossing the threads to form meshes of the net-work, and to afford an easy method of attaching them to the circular woods, after that they have been thus moved. In fig. 1, the circular woods are represented as turned half round, to shew the grooves and shuttles in them. The grooves in this case are perpendicular to the wooden stand: it must be observed, however, that they lie horizontally when the shuttles are moved from one circular wood to another. This is necessary both for weaving the net-work properly, and for moving the shuttles with greater facility.

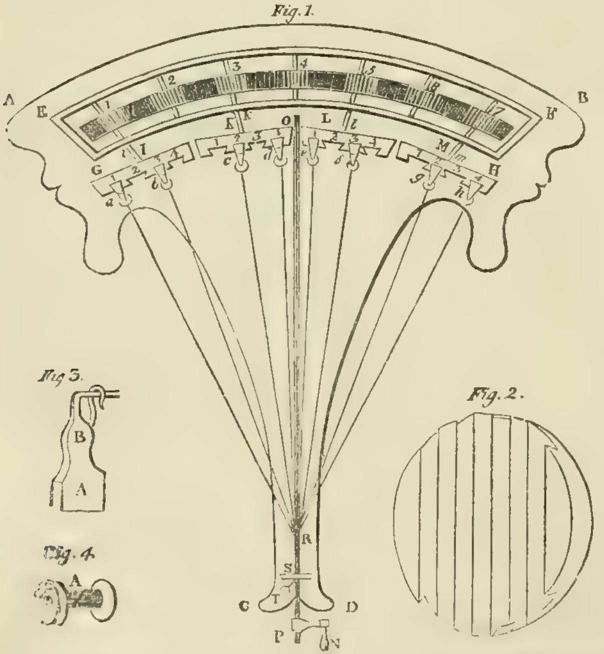


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 4, represents one of the pirns or bobbins. One end A, is considerably thicker than the other, and has a groove in it, which, when the pirn is put on C, fig. 3, admits a spring D. This spring acts as a counterpart to a weight that is suspended from the ends of the threvels, one of which proceeds from each pirn to keep them from entangling with each other. Each of the shuttles is furnished with a spring, all of which must individually be so strong, that their aggregate strength will prevent the weight from drawing the threads off the pirns, and at the same time sufficiently weak to allow the threads to come easily off the pirns when drawn by the operator. Into the centre wheel 4, fig. 1, another pitches, having the same number of teeth; this wheel, which cannot be represented in the figure, is fixed to one end of the iron rod O, P, and at the other end of it a handle N is fastened. By this handle the machine is put in motion. The iron rods O, P, turn in two gudgeons, one of which is concealed by the iron frame, the other is represented at S.

Having now given a description of Mr. Buchanan's simple and ingenious machine, the method of using it will easily be comprehended. The pirns having been previously filled with thread, or with any substance of which the net-work is to be wrought, are placed on the shuttles. The ends of the threads are then collected and tied together, after which they are put through a ring that is fastened on the top of the gudgeon S, fig. 1, and also through a hole T, in the sole or wooden stand; a weight is then suspended from the threads, the use of which, as was already mentioned, is to prevent them from entangling. It must be observed, however, that before the machine is put in motion, the shuttles occupy the proper grooves. This particular is illustrated in fig. 1, where the shuttles *a, b*, in the circular wood, I, occupy the second and fourth grooves; those of K, H, *c, d*, occupy the second and fourth; those of L, the first and third; and those of M, H, the second and fourth. The operator commences weaving the net-work by turning round the handle at N. The size of the meshes of the net-work, he enlarges or diminishes at pleasure, by turning the handle a greater or less number of times. By turning round the handle, the wheels in the iron frame, and the circular pieces of wood that are fixed to the axis of four of those wheels, are made to revolve; but when these pieces of wood are revolving, the threads which proceed from the shuttles of each are twining round each other. The twist made by this movement is made tight by the operator, who puts a finger of his left hand between each pair of threads, and with his right hand inserts, horizontally, the clearer, which is a thin piece of wood, shaped like a paper cutter, between each pair of threads, drawing both his hand and clearer towards R, at which place it is prevented from going any farther by a knot. He then removes his hand, leaving the clearer to keep the twist tight, and crosses the threads to form the meshes. This is effected by moving the shuttles from one circular wood to another. This operation resembles, and effects exactly, the same object as the crossing of the pins in working lace. The shuttles of the middle circular woods are charged first. Those of the circular wood R, occupying the second and fourth grooves, are moved into the second and fourth of the circular wood L, while those of L are shifted into the first and third grooves of K. This movement forms half a mesh. The operator then turns round the handle the same number of times as formerly, to twist the other sides of the mesh that is already half formed, and also to twist the sides of other two meshes. This being done, and the twist made tight by the method just explained, the threads are again crossed, which is done as formerly by moving the shuttles from one circular wood to another. In the former instance, only the threads of the middle circular woods were made to cross each other; in this, however, the whole must be crossed, and, consequently, all the shuttles will require to be moved into I; those of I into K; and those of L are moved into M; while those of M are moved into L.

By the first moving of the shuttles, those of the circular wood K were shifted into the corresponding grooves of L; and those of L were moved into the corresponding ones of K; so that by shifting them in the present instance, those that originally occupied the circular wood L, are moved into I; and those that originally occupied K are moved into M. This operation completes other two meshes. Thus, by twisting and crossing the threads, any quantity of net-work may be wove: the operator drawing more thread off the pirns as the former quantity is used.

In describing the method of using Mr. Buchanan's machine, we have called the substance with which the net work is wrought, thread. It is not to be understood, however, that this is the only substance which can be employed. It is a property of the machine that any kind of yarn or twine may be warped with it, so that by using fine yarn, and giving the handle a few turns, a texture may be wrought equally as fine as lace; and from the simplicity with which it may be wrought, we would strongly recommend the machine to the junior branches of families, who will find the using it to be an agreeable and profitable amusement.

**NEUTRAL SALTS**, a sort of salts neither acid nor alkaline, but partaking of the nature of both. *See* Acid, Alkali, Salts, &c.

**NEUTRALIZATION.** When two or more substances mutually destroy each other's properties, they are said to neutralize each other. Thus, in a proper combination of acid and alkaline substances, the acid and alkaline properties are destroyed.

**NEWTON, Dr. John**, a learned English mathematician, was born in Devonshire in 1622, and died in 1678, in the 56th year of his age. He was author of several works relating to different branches of the mathematical sciences, all of them exhibiting the hand of a complete master of his subjects.

**Newton, Sir Isaac**, one of the greatest mathematicians and philosophers that any age or country ever produced, was born at Woolstrop, in Lincolnshire, on the 25th of December, 1642. He very early discovered strong traits of genius, which was improved by a liberal education; at twelve years of age he was put to the grammar school at Grantham, and in 1660 was entered a student in Trinity College, Cambridge.

He had not been long in college before he attracted the notice of the celebrated Dr. Barrow, and a sincere and lasting friendship took place between these two great men. Euclid's "Elements" were as usual first put into his hands, of which he soon made himself master, and his attention was then directed to Descartes' analytical method, and the optics of Kepler, in both of which he made several improvements, noting them down in the margins. He continued reading the works of the most celebrated authors till about the year 1664, and at this early age it was that he first laid the foundation of his new and admirable Method of Fluxions and Infinite Series. In the mean time, as mathematicians were then much engaged in improving telescopes, and grinding glasses for the purpose of constructing these instruments, he also set himself to work on the same subject, which led him to a repetition of Grimaldi's celebrated experiment with the prism. The vivid colours of the spectrum was to him, not only a source of delight and pleasure, but also of contemplation, particularly its oblong form, which, according to the principles then received, ought to have been circular; this phenomenon led him to other experiments, and finally to a new theory of light and colours, in which the heterogeneous nature of light was satisfactorily demonstrated.

It is impossible for us to follow this philosopher through the numerous and important discoveries and improvements with which he enriched science; suffice it to say, that he left scarce any subject unexplored. Analysis, astronomy, optics, mechanics, were alike the objects of his investigation, and experienced alike the powerful effects of his superior genius. In his private character, he was amiable and modest; he never talked, either of himself or others, so as to give the most malicious censurer the least occasion even to suspect him of vanity. He was candid and affable, and always put himself upon a level with his company; nor did any singularities, either natural or affected, distinguish him from other men. This great man died on the 20th of March, 1727, in the 85th year of his age, and on the 28th of the same month was conveyed to Westminster Abbey, the pall being supported by the Lord Chancellor, the Dukes of Montrose and Roxburgh, and the Earls of Pembroke, Sussex, and Macclesfield. He was interred near the entrance into the choir on the left hand, where a stately monument is erected to his memory, with emblematical representations of some of his most important discoveries in the sciences, and an inscription highly honourable to his memory.

*The* Newtonian *Philosophy*, or the doctrine of the universe, and particularly the heavenly bodies, their laws, affections, phenomena, &c. as taught and illustrated by Newton.

**NEW TRIAL**, in Law, is not granted upon nice and formal objections, which do not go to the real merits, nor where the scales of evidence hang nearly equal. It is generally upon some misdirection by the judge to the jury, in point of law, where a jury has found a verdict directly against evidence. It is also granted where damages have been given beyond the ordinary measure of justice, and where the party has been surprised by some evidence which he has subsequently the means of answering, but had not at the trial. It is always refused where the damages do not exceed £10.

**NICKEL**, a white metal, which, when pure, is both ductile and malleable, and may be forged into very thin plates, whose colour is intermediate between that of silver and tin, and is not altered by the air. It is nearly as hard as iron. Its specific gravity is 8·279, and when forged, 8 666. The species of nickel ores are its alloy with arsenic and a little sulphur, and its oxide. The first is the most abundant, and the one from which nickel is usually extracted. It is known to mineralogists by the German name of kupfernickel, or false copper, from its colour and appearance. It occurs generally massive and disseminated, its colour is copper-red of various shades. By the experiments that have been made, nickel in its pure state possesses a magnetic power. The effect of the magnet on it is little inferior to that which it exerts on iron; and the metal itself becomes magnetic by friction with a magnet, or even by beating with a hammer. Magnetic needles have even been made of it in France, and have been preferred to those of steel, as resisting better the action of the air. The nickel preserves its magnetic property when alloyed with copper, though it is somewhat diminished; by a small portion of arsenic it is completely destroyed. Nickel is fusible at 150 degrees of Wedgwood, and forms alloy with a number of metals. Nickel is found in Cornwall, and in some other counties of England; in Germany, Sweden, France, Spain, and several parts of Asia. The Chinese employ it in making white copper; and, in conjunction with copper and zinc, they manufacture it into various kinds of children's toys. Nickel gives a certain degree of whiteness to iron. It is used, with advantage, by some of the Birmingham manufacturers, in combination with that metal; and by others in combination with brass. If it were possible to discover an easy method of working nickel, there can be little doubt but it would be found very valuable for surgical instruments, compass needles, and other articles, since it is not, like iron, liable to rust. Oxide of nickel is used for giving colours to enamels and porcelain. In different mixtures it produces brown, red, and grass-green tints.

**NICOTIANA**, in Botany, *Tobacco*, a genus of the pentandria monogynia class and order. Natural order of Luridæ. Solaneæ Jussieu. English tobacco seldom rises more than three feet in height, having smooth alternate leaves upon short foot-stalks; flowers in small loose bunches on the top of the stalks, of a yellow colour, appearing in July, which are succeeded by roundish capsules, ripening in the autumn. Sir Walter Raleigh, on his return from America, first introduced the smoking of tobacco into England. In the house in which he lived at Islington are his arms, with a tobacco plant on the top of the shield. It is remarkable that the name tobacco has prevailed over the original name, petum, in all the European languages, with very little variation, and even in Tartary and Japan. Tobacco is derived from the island Tobago. Petum is the Brazilian name.—Tobacco is sometimes used externally in unguents for destroying cutaneous insects, cleaning ulcers, &c. Beaten into a mash with vinegar or brandy, it has sometimes proved serviceable for removing hard tumours of the hypochondres.

**NICTITATING MEMBRANE**, in Comparative Anatomy, a thin membrane, chiefly found in the bird and fish kind, which covers the eyes of these animals, sheltering them from the dust, or from too much light, yet is so thin and pellucid that they can see through it.

**NIDUS**, among naturalists, a nest, or proper repository for the eggs of birds, insects, &c. wherein the young of these animals are hatched and nursed.

**NIGELLA** Romana. *Fennel Flower. The seeds.*—They have a strong, not unpleasant smell; and a subacrid, somewhat unctuous disagreeable taste. They stand recommended as aperient, diuretic, &c. but, being suspected to have noxious qualities, should be used with caution.

**NIGHT**, that part of the natural day during which the sun is below the horizon; though the twilight, both in the morning and evening, is sometimes considered as forming part of the day.

**NIHIL DICIT**, a failure in the defendant to put in an answer to the plaintiff's declaration, &c. by the day assigned for that purpose.

**NILOMETER**, sometimes called *Niloscope*, an instrument used among the ancients to measure the height of the water in the river Nile, in its periodical overflowings. The measure of it was sixteen cubits, this being the height to which it must rise, in order to insure the fruitfulness of the country.

**NIMBUS**, in Antiquity, a circle observed on certain medals, or round the head of some emperors, answering to the circles of glory drawn around the images of saints.

**NIPPERS**, certain pieces of cordage used to fasten the cable to the messenger, or voyal, in a ship of war, when the former is drawn into the ship by mechanical powers applied to the latter. They are usually six or eight feet in length, according to the size of the cable, and five or six of them are commonly fastened about the cable and voyal at once; those which are farthest aft are always taken off as the cable approaches the main hatchway, and others are at the same time fastened on in the fore part of the ship, to supply their places, the boys of the ship receiving the ends to walk aft with them, and carrying them forward again when cast off from the cable.

Nipper *Men*, persons employed to bind the nippers about the cables and voyal, and to whom the boys return the nippers when they are taken off. *Selvager* Nippers are used, when from a very great strain the common nippers are not found sufficiently secure; selvagers are then put on and held fast, by means of tree nails.

**NISI PRIUS**, in Law, a commission directed to the judges of assize, empowering them to try all questions of fact issuing out of the courts of Westminster, that are then ready for trial by jury: the origin of which name is this: all causes commenced in the courts of Westminster-hall, are by course of the courts appointed to be tried on a day fixed in some Easter or Michaelmas term, by a jury returned from the county wherein the cause of action arises; but with this proviso,—*Nisi prius justiciarii ad assisas capiendas venerint*; that is, unless before the day prefixed, the judges of assize come into the county in question, which they always do in the vacation preceding each Easter and Michaelmas term, and there try the cause. And then, upon return of the verdict given by the jury to the court above, the judges there give judgment for the party to whom the verdict is found.

**NITRATES**, compounds of nitric acid with the salifiable bases.

**NITRE**, the common name of the nitrate of potash, which is known by the name of saltpetre, and is found in the East Indies, in Spain, the kingdom of Naples, and elsewhere, in considerable quantities; but nitrate of lime is still more abundant. The greatest part of the nitre of commerce is produced by a combination of circumstances which tend to compose and condense nitric acid. This acid appears to be produced in all situations where animal matters are decomposed with access of air, and of proper substances with which it can readily combine. Grounds frequently trodden by cattle and impregnated with their excrements, or the walls of inhabited places where putrid animal vapours abound, such as slaughter-houses, drains, or the like, afford nitre by long exposure to the air. Artificial nitre-beds are made by an attention to the circumstances in which this salt is produced by nature. Its taste is penetrating; but the cold produced by placing the salt to dissolve in the mouth is such as at first to predominate over the real taste. Seven parts of water dissolve two of nitre, at the temperature of sixty degrees; but boiling water dissolves its own weight. One hundred parts of alcohol, at a heat of 176 degrees, dissolve only 2·9. On being exposed to a gentle heat, nitre fuses; and in this state being poured into moulds, so as to form little round cakes, or balls, it is called *sal prunella* or *crystal mineral.* Many kinds of plants, which grow in soils favourable to the production of it, contain nitre: this is particularly the case with pellitory, borage, and the large sun-flower. Immense quantities of nitre are annually required for the purposes of war. From its constituting one of the most important substances in the composition of gun-powder, it has been found necessary to adopt artificial modes of procuring it. In several districts of the East Indies, there are certain places called saltpetre grounds. From these, large quantities of the earth are dug, and put into cavities through which water is passed. This brings away with it the salt that the earth contains, and this is afterwards separated from the water by boiling. It is extensively employed in metallurgy; it serves to promote the combustion of sulphur in fabricating its acid; it is used in dying; it is added to common salt for preserving meat, to which it gives a red hue; it is an ingredient in some frigorific mixtures, and it is prescribed in medicine as cooling, febrifuge, and diuretic; and some have recommended it mixed with vinegar, as a very powerful remedy for sea scurvy.

Nitric *Acid*, is a compound of oxygen and azote, or nitrogen, in the proportion of twenty-five parts, by weight, of the latter to seventy-five of the former. It is one of the constituent parts of nitre or saltpetre, which from hence has its name; and, in a pure state, it is transparent and colourless, like water. By the action of light, however, it soon becomes yellow; and if exposed to the air, it emits yellow fumes, which even tinge the air of the same colour. To the taste it is extremely acid. It dyes the skin a yellow colour, which is very difficult to be removed, and is so corrosive as to destroy almost every substance into which it penetrates. If poured upon oils, it sets them on fire. With various bases it forms the compounds called *nitrates.* This acid, which has hitherto never otherwise been obtained than mixed with water, is chiefly known in commerce by the name of *aqua-fortis.* Its uses are various and important. The mode of obtaining it, in large manufactories, is by distilling a mixture of nitre and clay; but the acid thus procured being weak and impure, chemists, for nicer purposes, generally prepare it by distilling, in a glass apparatus, a proportion of three parts of nitre and one of spirit of vitriol. All kinds of metals are capable of being dissolved by nitric acid except gold and platina. For all practical purposes, nitric acid is obtained from nitrate of potash, from which it is expelled by sulphuric acid; and it is of considerable use in the arts, being employed for etching on copper; as a solvent of tin to form with that metal a mordant for some of the finest dyes; in metallurgy and assaying; in various chemical processes, on account of the facility with which it parts with oxygen and dissolves metals; in medicine, as a tonic, and as a substitute for mercurial preparations in syphilis and affections of the liver; as also in the form of vapour, to destroy contagion in all cases of fever. For the purposes of the arts it is used in a diluted state, and contaminated with the sulphuric and muriatic acids, by the name of aquafortis. Two kinds are sold in the shops, double aquafortis, which is about half the strength of nitric acid; simple aquafortis, which is half the strength of the double. A compound made by mixing two parts of the nitric acid with one of muriatic, known formerly by the name of aqua regia, and now by that of nitro-muriatic acid, has the property of dissolving gold and platina. On mixing the two acids heat is given out, an effervescence takes place, and the mixture acquires an orange colour. The aqua-regia does not oxydize gold and platinum, but causes their combination with chlorine. The nitrate of barytes, when perfectly pure, is in regular octahedral crystals, though it is sometimes obtained in small shining scales. It may be prepared by uniting barytes directly with nitric acid, or by decomposing the carbonate or sulphuret of barytes with this acid. Nitrate of strontian may be obtained in the same manner as that of barytes, with which it agrees in the shape of its crystals, and most of its properties. Applied to the wick of a candle, or added to burning alcohol, it gives a deep red colour to the flame. On this account it is useful in the art of pyrotechny and in exhibitions at public theatres. Nitrate of lime abounds in the mortar of old buildings, particularly those that have been much exposed to animal effluvia, or processes in which azote is set free. The nitrate of ammonia possesses the property of exploding, and being totally decomposed at the temperature of 600 deg.; whence it has acquired the name of nitrum flammans.

**NITROGEN**, also called azote, a substance existing in great abundance, but is never found except in combination with some other body. Is a principal component part of the air which we breathe, which consists of 78 parts of nitrogen, and 22 of oxygen. It is accordingly here united with oxygen, and a certain portion of caloric and light. The nitrogen and oxygen of the atmospheric air may be separated, so that we may have the nitrogen by itself, but then only in a state of gas, and its properties are very different from those of the atmospheric air. Nitrogen gas will not support animal life. It is a little heavier than atmospheric air, elastic, and capable of expansion and condensation. It produces no change on vegetable colours, and, when mixed with lime water, does not make it milky, as does carbonic acid gas. Nitrogen gas and oxygen gas artificially mixed in proportions in which air is found in the atmosphere, have exactly the same properties as atmospheric air, which they become in every respect. All animal and vegetable substances contain a large portion of nitrogen. Different proportions of oxygen united with nitrogen produce compounds of very different properties: 78 parts of nitrogen and 22 of oxygen will produce atmospheric air. The same quantity of nitrogen with twice as much of oxygen make 100 of nitrous oxide. The same quantity of nitrogen and four times as much oxygen make nitric oxide. The same quantity still of nitrogen and eight times the quantity of oxygen, make nitrous acid. The same quantity of nitrogen, and ten times the quantity of oxygen, make nitric acid. Thus the only difference between atmospheric air, so necessary to life, and nitric acid, which would destroy us if received internally, consists in this, that the latter contains ten times as much oxygen as the former. Nitrous oxide, a gas chiefly remarkable for its intoxicating effects when inhaled, affords at public lectures much amusement to the spectators. It is obtained by distilling nitrate of ammonia. Nitrous oxide and nitrous acid are not of much importance. Nitrogen combines with chlorine, and is then dangerously explosive, and must be carefully and cautiously heated. It unites also with iodine.

**NITROUS ACID**, formerly called fuming nitrous acid, forms a distinct genus of salts, that may be termed nitrites.

**NOBILITY**, a quality that ennobles, and raises a person possessed of it above the rank of a commoner. The origin of nobility in Europe is referred to the Goths, who, after they had seized part of Europe, rewarded their chiefs with titles of honour, to distinguish them from the common people. In Britain the term nobility is restrained to the degrees of dignity above knighthood; but every where else nobility and gentility are the same. The British nobility consist only of five degrees, *viz.* duke, marquis, earl or count, viscount, and baron. In Britain these titles are conferred only by the king, and that by patent, in virtue of which it becomes hereditary. The privileges of the nobility are considerable, they are the king's hereditary counsellors, and are privileged from all arrests unless for treason, felony, breach of peace, condemnation in parliament, and contempt of the king. They enjoy their seats in the House of Peers by descent, and no act of parliament can pass without their concurrence; they are the supreme court of judicature, and even in criminal cases give their verdict upon their honour, without being put to their oath. In their absence, they are allowed a proxy to vote for them, and in all places of trust are permitted to constitute deputies, by reason of the necessity the law supposes them under, of attending the king's person; but no peer is to go out of the kingdom without the king's leave, and, when that is granted, he is to return with the king's writ, or forfeit goods and chattels.

**NOBLE**, a money of account containing six shillings and eight pence.

**NOCTILUCA**, a species of phosphorus.

**NOCTURNAL** Arch, in Astronomy, the arch of a circle described by the sun, or a star in the night.

Nocturnal *Semi Arch of the Sun*, is that portion of a circle he passes over between the lower part of our meridian, and the point of the horizon wherein he rises; or between the point of the horizon wherein he sets, and the lower part of our meridian.

Nocturnal, or *Nocturlabium*, an instrument chiefly used at sea, to take the altitude or depression of some stars about the pole, in order to find the latitude and hour of the night. Some nocturnals are hemispheres or planispheres, on the plane of the equinoctial. Those commonly in use among seamen are two; the one adapted to the polar star, and the first of the guards of the little bear; the other to the pole star, and the pointers of the great bear.

This instrument consists of two circular plates applied to each other. The greater, which has a handle to hold the instrument, is about 2½ inches diameter, and is divided into twelve parts, agreeing to the twelve months, and each month subdivided into every fifth day; and so as that the middle of the handle corresponds to that day of the year wherein the star here regarded has the same right ascension with the sun. If the instrument be fitted for two stars, the handle is made moveable. The upper left circle is divided into twenty-four equal parts for the twenty-four hours of the day, and each hour subdivided into quarters. These twenty-four hours are noted by twenty-four teeth, to be told in the night. Those at the hour twelve are distinguished by their length. In the centre of the two circular plates is adjusted a long index, moveable upon the upper plate. And the three pieces, *viz.* the two circles and index, are joined by a rivet, which is pierced through the centre with a hole, through which the star is to be observed.

To use the Nocturnal:—Turn the upper plate till the long tooth, marked twelve, be against the day of the month on the under plate: then bringing the instrument near the eye, suspend it by the handle with the plane nearly parallel to the equinoctial; and viewing the pole star through the hole of the centre, turn the index about, till, by the edge coming from the centre, you see the bright star, or guard of the little bear, (if the instrument be fitted to the star); then that tooth of the upper circle, under the edge of the index, is at the hour of the night on the edge of the hour circle: which may be known without a light, by counting the teeth from the longest, which is for the hour twelve.

**NODE**, in Surgery, a tumour arising on the bones.

**NODE**, Nodus, in the doctrine of Curves, is a small oval figure, made by the intersection of one branch of a curve with another.

Node, in Dialing, denotes a small hole in the gnomon of a dial, which indicates the hour by its light, as the gnomon itself does by its shadow.

Nodes, in Astronomy, are the opposite points where the orbit of a planet crosses the ecliptic.

*Ascending* Node, is that where the planet ascends from the south to the north side of the ecliptic, which is denoted by the character ☊, and denominated *dragon's head*. *Descending* Node, is that where the planet descends from the north to the south side of the ecliptic, which is denoted by the character ☋, and is called the *dragon's tail*. The right line joining these two points, is called *the line of the nodes*. It appears by observation, that in all the planets the line of the nodes continually changes its place, its motion being in antecedentia, or contrary to the order of the signs, the particular quantity for which, in each planet, will be found under their several names.

**NOLLE** Prosequi, is used where the plaintiff will proceed no further in his action.

**NO-MAN'S-LAND**, a space in midships, between the after part of the belfry and the fore part of a boat, when she is stowed upon the booms, as in a deep waisted vessel.

**NOMENCLATURE.** The chemists of former times were unfortunate in the nomenclature which they adopted, there being no regular system, and the names given to chemical substances being frequently fanciful and often leading to error. In addition to this, chemists affected obscurity and mystery. To obviate these inconveniences, Lavoisier and the French chemists proposed, and successfully introduced, a chemical nomenclature, of which the basis is simplicity, and which is intended as far as possible to convey an idea of the composition of the substance expressed.

**Nomenclature**, a catalogue of several of the most usual words in any language, with their significations, to facilitate the use of such words to those who are to learn the tongue.

**NONAGESIMAL Degree**, called also *Mid Heaven*, is the highest point, or 90th degree of the ecliptic, reckoned from its intersection with the horizon at any time.

**NONAGON**, a figure of nine angles and nine sides. The angle at the centre of a nonagon is 40°, the angle subtended by its sides 140°, and its area when the side is $1 = \frac{9}{4}$ nat. tang. $70° = 6{\cdot}1818242$.

**NONAPPEARANCE**, a default in not appearing in a court of judicature. Attorneys subscribing warrants for appearing in court are liable to attachment and fine for nonappearance. If a defendant does not appear, and find bail upon a *scire facias* and rule given, judgment may be had against him.

**NON COMPOS MENTIS**, in Law, denotes a person not being of sound memory and understanding.

**NON CLAIM**, in Law, where a person has a demand upon another, and does not enforce his claim within a reasonable time, he is precluded by law from bringing his action to enforce it. Non claim is generally applied to the period of five years, after which a party is barred by a fine.

**NONCONFORMISTS**, the same with dissenters, of whom there are numerous separate congregations in these kingdoms.

**NONES**, **Nonæ**, in the Roman calendar, the fifth day of January, February, April, June, August, September, November, and December; and the seventh of March, May, July, and October, had six days in their nones; because these alone, in the ancient constitution of the year by Numa, had 31 days apiece, the rest having only 29, and February 30; but when Cæsar reformed the year, and made other months containing 31 days, he did not allot them six days of nones. *See* Calendar.

**NON EST FACTUM**, a plea where an action is brought upon a bond, or any other deed, and the defendant denies it to be his deed whereon he is impleaded. In every case where the bond is void, the defendant may plead *non est factum*; but where a bond is voidable only, as the law terms it, he must shew the special matter.

**Non est Inventus**, signifies a sheriff's return to a writ, that the defendant is not to be found.

**NONIUS**, or **Nunez, Peter**, an eminent Portuguese mathematician and physician, was born at Alcazar, in Portugal, in 1497, and died in 1577, at the age of 80 years. From this author is derived the name of the instrument called the nonius, from his having described it in one of his works. The invention of it is, however, more commonly attributed to Vernier, by which name it is also sometimes called, and under which it is described in this work.

**NON-NATURALS**, in Medicine, so called because by their abuse they become the causes of diseases. The old physicians divided the non-naturals into six classes, *viz.* the air, meats and drinks, sleep and watching, motion and rest, the passions of the mind, the retentions and excretions.

**NON-PROS**, in Law, if the plaintiff neglects to deliver a declaration for two terms after the defendant appears, or is guilty of other delays or defaults against the rules of law in any subsequent stage of the action, he is adjudged not to pursue his remedy as he ought; and thereupon a non-suit or nonprosequitor is entered, and he is then said to be non-pros'd.

**Non-Residence**, in Ecclesiastical matters, is applied to those spiritual persons who are not resident, but absent themselves for the space of one month together, or two months at several times in one year, from their dignities or benefices, which is liable to the penalties, by the statute against non-residence, 21 Henry VIII. c. 13. But chaplains to the king, or other great persons mentioned in this statute, may be non-resident on their livings; as they are excused from residence whilst they attend those who retain them.

**NONSUIT**, in Law, is where a person has commenced an action, and, at the trial, fails in his evidence to support it, or has brought a wrong action. The plaintiff pays costs, but may bring another action for the same cause, which he cannot do after a verdict against him.

**NORIA**, an hydraulic machine, common in Spain, which raises water. This engine consists of a vertical wheel of 20 feet diameter, on the circumference of which are fixed buckets, or boxes, for the purpose of raising water out of wells, &c. communicating with the canal below, and emptying it in a reservoir above, placed by the side of the wheel. The buckets have a lateral orifice, to receive and discharge the water. The axis of the wheel is embraced by four small beams, crossing each other at right angles, tapering at the extremities, and forming eight little arms. This wheel is near the centre of the horse-walk, contiguous to the vertical axis, into the top of which the top beam is fixed; but near the bottom it is embraced by four little beams, forming eight arms, similar to those above described, on the axis of the water wheel. In the movement of the horse or mule, these horizontal arms acting as cogs, take hold, each in succession, of those arms, which are fixed on the axis of the water wheel, and keep it in rotation. This machine, nearly resembling the Persian wheel, throws up a great deal of water; but it has two defects: much of the water falls out of the buckets in their ascent, and a considerable portion of the water to be discharged falls into the reservoir just when the bucket is at its highest point of the circle. These inconveniences are both remedied by the Persian Wheel; which see.

**NORMA vel QUADRA EUCLIDIS**, ***Euclid's Square***, is a small constellation situated south of the Scorpion, and contains twelve stars, all below the fourth magnitude.

**NORMAL**, a perpendicular forming with another line a right angle.

**NORMAN**, a name given to a short wooden bar, thrust into one of the holes of the windlass in a merchantman, whereon to fasten the cable. It is only used when there is very little strain upon the cable.

**NORTH**, one of the four cardinal points.

**North-East Passage.** This navigation has been divided into three parts, and the advocates for it have endeavoured to shew that these three parts have been passed at different times, concluding from thence, that the whole taken collectively is practicable. These three parts are, 1. From Archangel to the river Lena; 2. From the Lena round Tschukotskoi Noss (or the north-eastern promontory of Asia) to Kamschatka; and 3. From Kamschatka to Japan. With respect to the first part, no one has ever asserted that it has been performed in one voyage. From an account of the several voyages that have been made in these seas, it appears that there is a cape between the rivers Chalanja and Piasida, that has never yet been doubled. As to the second division, it has been affirmed, that a passage has been effected by several vessels which have at different times sailed round the northern extremity of Asia. But from the Russian accounts it is inferred, that it has been performed but once, *viz.* by one Deshneff, who, in 1648, is said to have doubled this formidable cape. Of the third, or remaining part, of this passage, no doubt can be entertained. The connexion between the seas of Kamschatka and Japan has been established by many voyages.

**North-*West Passage***, by Hudson's or Baffin's bay, into the Pacific ocean.

**NORTHERN Signs**, are those that are on the north side of the equator *viz.* Aries, Taurus, Gemini, Cancer, Leo, and Virgo.

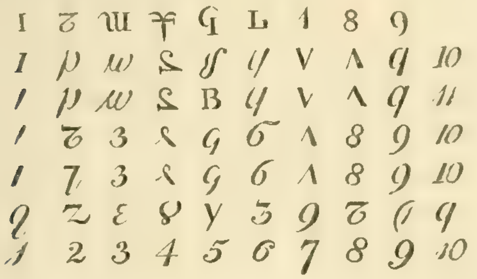
**NORTHING**, in Navigation, is the difference of latitude which a ship makes in sailing towards the north.

**NOSTOCK**, the name of a vegetable substance, of a greenish colour, partly transparent, and of a very irregular figure. It trembles at the touch, like jelly, but does not melt like that. It is found in all, but most frequently in sandy soils, usually after rain in summer.

**NOTARIAL Acts**, are those acts in the civil law, which require to be done under the seal of a notary, and are admitted as evidence in foreign courts.

**NOTARY**, in Law, is a person duly appointed to attest deeds and writings; he also protests and notes foreign and inland bills of exchange and promissory notes, translates languages, and attests the same, enters and extends ship's protests, &c.

**NOTATION**, in Arithmetic, the method of expressing, by means of certain characters, any proposed quantity. In the modern analysis, notation implies a method of representing any operation, and the judicious selection of proper symbols for this purpose is an important consideration, which every author who undertakes to write on this subject should particularly attend to. In the common scale of notation every number is expressed by means of the ten characters, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, by giving to each digit a local as well as its proper or natural value, the discovery of which was perhaps one of the most important steps that has ever been made in mathematics, and does as much honour to its inventor as any other in the history of this science. With regard to the characters or digits, by which numbers are at this date universally expressed, they seem to be the same, with a very slight alteration, as those that were originally employed for that purpose; but their forms are not such as to indicate their origin, though some authors have discovered more ingenuity than judgment, by endeavouring to trace them to the Greek alphabet, and hence inferring, contrary to every evidence, a Grecian origin to our present system of notation. See the different arithmetical characters in the following engraving



**NOTATION of the *Hebrews*,** resembled, in a great measure, that of the Greeks above described; thus,

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Instead of our units,............... | 1, | 2, | 3, | 4, | 5, | 6, | 7, | 8, | 9, |
| The Hebrews used their letters,.... | א, | ב, | ג, | ד, | ה, | ו, | ז, | ח, | ט. |
| For our tens, as.................... | 10, | 20, | 30, | 40, | 50, | 60, | 70, | 80, | 90, |
| They employed ...................... | י, | כ, | ל, | מ, | נ, | ס, | ע, | פ, | צ. |
| For the hundreds they used ....... | ק, | ר, | ש, | ת, | ך, | ם, | ן, | ף, | ץ. |

And for representing thousands, they had again recourse to their simple units, distinguishing them only by two dots, or acute accents, thus א̈, or א″, expressed 1000; ב̈ 2000; י̈ 10000, and so on.

**NOTATION of the *Greeks*.** These people had three distinct notations; the most simple of which was, by making the letters of their alphabet the representatives of numbers, α, 1; β, 2; γ, 3; and so on. Another method was by means of six capital letters, thus, I [ια for μια] 1; Π [πεντε] 5: Δ [δεκα] 10; H [Hεκατον] 100; X [χιλια] 1000; M [μυεια] 10000; and when the letter Π enclosed any of these, except I, it indicated the enclosed letter to be five times its proper value, as stated above; thus, $\overline{|\Delta|}$ represented 50; $\overline{|\text{H}|}$ 500; $\overline{|\text{X}|}$ 5000, and so on. This notation was only used to represent dates and similar cases; for arithmetical purposes they had a more organized system, in which thirty-six characters were employed, and by these any number not exceeding 100000000, might be expressed, though in the first instance it appears that 10000, or a myriad, was the extent of their arithmetic.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Our digits,........................ | 1, | 2, | 3, | 4, | 5, | 6, | 7, | 8, | 9, |
| They expressed by the letters .... | α, | β, | γ, | δ, | ε, | ϛ, | ζ, | η, | θ. |
| For our tens, as .................. | 10, | 20, | 30, | 40, | 50, | 60, | 70, | 80, | 90, |
| They employed the letters ...... | ι, | κ, | λ, | μ, | ν, | ξ, | ο, | π, | ϟ. |
| The hundreds were expressed by.. | ρ, | σ, | τ, | υ, | φ, | χ, | ψ, | ω, | ϡ. |
| And the thousands by ........... | ͵α, | ͵β, | ͵γ, | ͵δ, | ͵ε, | ͵ϛ, | ͵ζ, | ͵η, | ͵θ. |

That is, they had recourse again to the characters of the simple units, which were distinguished by a small iota or dash placed below them; and with these characters a number under 10000 was readily expressed; and this, as we have observed above, was, for some time, the limit of their arithmetic. Afterwards 10000, or a myriad, was represented by M, and any number of myriads by M placed under the number of them. Thus,

| | α | β | γ |
|---|---|---|---|
| | M. | M. | M. |
| represented | 10000 | 20000 | 30000, &c. |

**NOTATION of the *Romans*.** This is still employed by us for dates and other similar purposes, and is too well known to require a very minute description. The Roman numerical characters are seven in number; *viz* I. one; V. five; X. ten; L. fifty; C. a hundred; D. or IↃ. five hundred; M. one thousand; this last number is also sometimes expressed by Dꟷ, or by CIↃ. And by the various combinations of these characters, any number whatever might be expressed, as in the following table:—

1 = I.
2 = II. } As often as any character is repeated,
3 = III. } so many times is its value repeated.
4 = IV. } A less character before a greater, diminishes its value by the less quantity.
5 = V.
6 = VI. } A less character after a greater, increases its value by the less quantity.
7 = VII.
8 = VIII.
9 = IX.
10 = X.
11 = XI.
40 = XL.
50 = L.
60 = LX.
100 = C.
500 = D. or IↃ. } For every Ↄ added, this becomes ten times as much.
1000 = M. or CIↃ. } For every CↃ, set one at each end, this becomes ten times as much.
5000 = IↃↃ. or $\overline{\text{V}}$. } A line over any figure increases it 1000 fold.
6000 = $\overline{\text{VI}}$.
10000 = $\overline{\text{X}}$. or CCIↃↃ.
50000 = IↃↃↃ.
60000 = LX.
100000 = $\overline{\text{M}}$ or CCCIↃↃↃ.
1000000 = $\overline{\text{MM}}$. or CCCCIↃↃↃↃ.

**NOTATION**, in Music, the manner of expressing or representing by characters, all the different sounds used in music.

**NOTE**, a minute or short writing containing some article of business; in which sense we say promissory note, note of hand, bank note, &c.

**NOTE, *Bank*.** The paper currency of any bank, as of the Bank of England, that of Scotland or Ireland, or of any provincial or private bank.—This currency is known as bank-paper, or bank-note, and this note is usually printed on a particular sort of paper, from an engraved plate. The consideration of every such engraving, but for the sake of alphabetical reference, would in this Dictionary belong to the word engraving or printing: it falls most naturally under the word NOTE. But as preliminary explanations, we shall here define accurately the two species of engraving that have been heretofore employed in printing bank-notes:—First, then, there is employed *engraving in Creux*, or copper-plate engraving, where the line or figure intended to be printed is cut down into the copper. This line, in printing, is filled with the ink, and the intermediate surface being cleaned off after the plate has been charged, contains of course no ink, and leaves the paper white. This mode of printing is called *copper-plate printing*. Secondly, *engraving in Relief*, wherein the lines or figures, intended to be printed on the paper, are left standing on the plate, the intermediate parts being cut away. In this case, which is exactly the converse of the former, the ink is applied to the surface only of those raised lines or figures, and from them it is transferred to the paper; the intermediate excavated parts containing no ink, and therefore leaving the paper white. This mode of printing is called *surface printing*, and is the same as *type, stereotype*, or *letter-press printing*. It is also called *wood-cut* or *block-printing*, because all engravings in wood are printed from the surface, *i. e.* the *relief*. Hence, to produce a *white* line or figure on a *black ground* from copper-plate printing, the line or figure must be raised; while to produce the same by *surface* or *relief printing*, the line or figure must be sunk, and the contrary, as to the *black* line; for, that which produces the *black* line in one case, produces the *white* line in the other, and consequently, as it is evidently more difficult to produce the raised work or *cameo*, than the sunk work or *intaglio*, so the white line, which is the most difficult to produce in copper-plate printing, is the most easy in surface printing; while the black line, which it is easy to produce in copper-plate printing, is difficult in surface printing: in short, that which is difficult in either case, is easy in the other; so that where these respective styles can be interchanged and mixed by separate impressions, there is no difficulty in the production either of the white or the black line, how complicated soever may be the figure. Any bank-note therefore, printed from the combination of these two modes of engraving, and at two separate impressions, may be accurately imitated, and the public deceived by a false security. Now, then, the great means to be accomplished in securing the paper currency, is, to discover a mode of producing some effect in paper, which can only be imitated by the same process as that by which the original note is created, so that the forger shall be compelled to encounter all the difficulties of the original in his attempts at imitation. We have only seen one plan that possesses this most essential property, and this plan is the *Patent Compound Plate*, for printing in *two* or *more colours* at *one impression*, which, with a delicacy and variety in the colouring and workmanship that belong exclusively to this invention, certainly offers the most simple test of genuineness to the public. Indeed, such are the variety and capability of this plan of engraving and printing, that it falls within the power of fewer persons to imitate, than any other known branch of the graphic art applicable to bank-notes.

The *Specimen Plate* which Messrs. Whiting and Branston have executed for this Dictionary, reduces the question of security against forgery to two immediate objects:—First, it proves that the means of real security in bank-notes do exist, and it is therefore calculated to promote general confidence (against forgery) in the bank-notes executed by Messrs. Whiting and Branston. Secondly, it shews in what way the true principles of protection may be extended to every branch of the paper currency of Great Britain and Ireland, to the provincial paper as well as that of the Bank of England, without either of these branches interfering with or diminishing the security of the other.

It is true, that there is nothing new in printing in two colours, or even in all the colours of the rainbow; the former has been practised by ordinary means for many years in the lottery shares and bills, and in title-pages, &c.; the latter is adopted daily, in printing calicoes, paper-hangings, oil-cloths, &c. It is not presumed, therefore, to appropriate this branch of art exclusively to the security of bank-notes; still, however, we may look to certain peculiarly refined applications of it for the accomplishment of that object; and as there is no real security against forgery to be achieved in *one* colour, it must consequently be sought for in the combination of two or more colours; and, indeed, the extension of field thus obtained for the exercise of variety, ingenuity of combination, and difficulty of execution, especially in printing, will be found utterly to defy imitation by any of the ordinary modes of printing in two colours.

These details we derive from Sir William Congreve's "Analysis of the true Principles of Security against Forgery," inscribed to the Earl of Liverpool. The public are already in possession of a small volume which Sir William published on the protection of the metallic currency. As one of the commissioners of inquiry as to the best means of preventing forgery, Sir William Congreve employed Mr. Branston to imitate, in wood and copper engravings, portions of the notes which the American artists presented to the Bank of England as inimitable, or which, at least, would take years of the forger's time to imitate. Now, five heads of a Homer, which the American artists engraved on copper in three months, Mr. Branston, senior, cut in wood in four days, and an exact copy too from which five fac-simile heads of the Grecian bard were printed precisely similar to the American artists' Homers. A portion of fine writing in eight small ovals, being part of the Bank Charter, and containing 20,000 letters, occupied the American artists six months. Mr. Branston, senior, who had never written on copper before, engraved or wrote these 20,000 letters in six days, and had them stereotyped. They are invisible to the naked eye; but are perfectly distinct with a magnifying glass of high power. But the Bank Charter thus engraved, and having the merit of being perfectly illegible in both the American original and Mr. Branston's copy, is no security against forgery. This trumpery piece of fine writing is a piece of idle labour, on the part of the American artists. Then, again, in the American inimitable, there is a border engraved with a geometrical lathe, to which is attributed the power of free will, and a little of that perverseness which sometimes accompanies the exercise of that power, inasmuch as, it is broadly stated by the Transatlantic volume, (page 27,) "that it is not to be made (adjusted) to produce the same pattern twice!" The volume before us, speaks of "the impossibility of doing this work with the graving tool," and it occupied thirty months; yet Mr. Branston, junior, then only eighteen years of age, imitated it in five days. Some female heads on the same note, that occupied another American artist about two months, were cut in wood by Mr. Branston in two days. This American note is now before us. It contains five heads of a Homer, engraved by Mr. Perkins the younger; four female heads, engraved by Colonel Farman; two pieces of border, produced by the geometrical lathe, resembling the volutes of a certain number of lines, like the twine and strands of a cable, more or less twisted, and perfectly shewn in the Plate of my own Dictionary, and either drawn out straight, or bent into coils. Inlaid in the borders thus produced, are eight fac-simile ovals, containing part of the Bank Charter, *perfectly* illegible without the aid of a high magnifying glass. And the time which the American writers estimate it would cost the forger to imitate this note, is three years and ten months. All which was imitated excellently enough for the use of any forger, by the Branstons, father and son, in seventeen days, and by hand too, without the aid of machinery. There is another note, which though suppressed in the printed volume of the American artists, is the sixth specimen in Sir William Congreve's work, and which, according to the estimate of its fabricators, would take the forger five years; but which Mr. Branston, his son, and a second-rate engraver, imitated perfectly in thirty-three days, and by hand, without the aid of machinery.

Having thus briefly noticed the facility with which the most elaborately engraved bank-notes may be imitated, we come now to describe the *Compound Patent Plate*, the particular application of which to Bank of England notes, in one or two particulars, we shall not, of course for obvious reasons, venture to describe. Though this plate is compound, its operation by a simultaneous impression is entirely different from that which the Bank employs, not only as to the mode in which the effect is produced, but also as to its manner of effecting the security of the note. In fact, the particular effect of printing in colours, selected for a portion of the security of the Bank of England note, cannot be imitated by the Compound Plate, while the characteristic work of the Compound Plate cannot be produced by separate impressions; so that no use of the latter, however public, could tend, in the least, to facilitate the imitation of the former. It is evident, therefore, that although the general principle of printing in colours is found to be the best means of security against forgery, still there is a sufficient variety to be derived from this general principle, not only for the protection of the notes of the Bank of England, but for those also of the Country Banks, without *either* invalidating the *other*. The Bank of England may, therefore, specify the peculiar system of the combination of colours, which they have adopted, as part of their security; and they may confine this to themselves by a protecting act of parliament, without at all interfering with the peculiar security of the Compound Plate; and this latter plan of printing in two or more colours, may

Dr. JAMIESON'S
DICT. of MECL. SCIENCE
SPECIMEN
OF
Patent Compound Plate
on a NEW PLAN by
WHITING & BRANSTON
Beaufort House, Strand
FOR THE PREVENTION
H. FISHER, SON & Co.

also be secured to the other branches of the Paper Currency, without the least effect upon the protection of parliament granted to the Bank of England Note.

It has been already observed, that the Compound Plate is in fact the application of certain principles illustrated by Sir William Congreve in his book on the Metallic Currency, not to be counterfeited without immediate detection. It is curious to observe the applicability of these same principles to the security both of coin and paper currency. That which is the coin in the one case, becomes the plate for the printing from in the other; and the delicate and perfect *union of colours*, which will be found to be thus effected *on the paper*, produces a similar, though not so positive a test of originality, by its coincidence and adaptation, as that which the union of the *metals* themselves gives in the coin: but this will be better understood by the sequel.

These plates are made of two metals, of which one must be of brass, copper, or other metal at least as strong. The design is first drawn on the brass plate; the parts in which it is intended to introduce the second colour, are then cut out in the most delicate *filigree*. A second plate is then combined with the first, by a process peculiar to this sort of workmanship, the parts of which are fitted most accurately into all the interstices of the brass plate; and, indeed, the fineness of the filigree is by hypothesis such, that the combination can only be formed by this peculiar mode of uniting the two metal plates, which are then engraved as one; and for printing, they are fixed in a press of peculiar construction, so that they may be separated to receive a different *coloured* ink on *each* plate, and unite again to print whatever work may be engraved, or otherwise placed upon them, in two colours at one impression.

Thus, in the Specimen Plate before us, all those parts of the engraving which bear the red colour, as my own name, that of the publisher, and the various crescents or devices, may be considered the second colour workmanship cut out in filigree in the first plate, while the black ground exhibits the second plate combined with the first. By this means, the most beautiful and delicate junction of colour is effected. The finest lines, though formed of various portions of different colours, flow as perfect as if produced in one colour by the stroke of an indivisible plate; a single point may be found of the two colours in perfect union; and the most beautiful and correct adaptations of colour and complicated variety of forms may be made, so as utterly to defy imitation by any of the ordinary processes of printing in two colours. In fact, if sufficient art be resorted to, in combining this tissue of extremely nice and delicate colour over the whole surface of the Compound Plate, it is evident, the whole of the work on the note must be produced by one simultaneous operation of the forger, and cannot, like the American note, be imitated in any way that proceeds by a repetition of impressions.

We have only in conclusion to add, that we will give one hundred guineas to any artist who, by two impressions of printing in two colours, shall produce the fellow of Whiting and Branston's Compound Plate, as engraved and printed for Dr. Jamieson's Dictionary of Mechanical Science.

NOTES, in Music, are characters which by their various forms and situation on the staves, indicate the duration as well as the gravity or acuteness of the several sounds of a composition.

NOT GUILTY, the general issue or plea of a defendant, in a criminal action or prosecution; as also in an action of trespass, or upon the case for deceits and wrongs.

NOTICE, in Law, is the making something known of which a man was or might be ignorant before, and it produces divers effects.

NOUN, in Grammar, a part of speech which signifies things without any relation to time; as a man, &c.

NOVEL, in the Civil Law, a term used for the constitution of several emperors, as of Justin, Tiberius, Leo, and more particularly for that of Justinian.

Novel *Assignment*, or *New Assignment*, a term in law pleadings. In actions of trespass, where the form of the declaration being very general, the defendant pleads in bar a common justification; to which the plaintiff replies by stating, that he brought his action as well for a certain other trespass which he states with more particularity, as for that which is justified,—this is called a new assignment.

NOVEMBER, the eleventh month in the Julian year, but the ninth in the year of Romulus, beginning with March, whence its name. In this month, which contains thirty days, the sun enters the sign Sagittarius ♐, usually about the twenty-first day of the month.

The Kalendar of *Animated Nature* for November, round London, informs us, that the buck grunts, the golden plover appears, snails and slugs bury themselves, greenfinches flock, the winter moth and the common flat-body moth appear in gardens about the end of the month.

That of *Vegetable Nature*, shews a few accidental annual plants in flower, according to the temperature of the season. The laurustinus and the calicanthus præcox are in flower, as are some primroses.

In the *Kitchen Garden*, are sown short-topped radishes on a warm border, and pease and beans; celery, endive, artichoke, and seakale, are protected; potatoes left in the ground, are taken up as wanted. Outstanding edible roots are covered with litter or leaves; cauliflowers by hoops and mats.—Perennials are propagated, and any thing to be transplanted, and that has been omitted in October, must now be removed.

In *Routine Culture*, all operations on the earth, excepting digging and trenching, must be performed only in dry weather. Dress artichoke and asparagus beds; take up endive, broccoli, and cauliflower, and lay them flat in dry ground. Weed all seedling crops. Dig, trench, and manure. Destroy insects, and fill the icehouse if you can.

In the *Hardy Fruit Department*, plant trees in dry weather, stake and mulch both root and stem, especially tall standards of the pithy wooded sorts. Prune vines, dig, dress, and prune hardy fruit trees: the nectarine, peach, and apricot, should be deferred till spring. Examine the fruit room, and clear it of all decaying fruits.

In the *Culinary Hot-house Department*, glass-case without artificial heat, sow small salads, and pease and beans, to transplant or remain. Attend to air, and removing decayed leaves. Transplant lettuces from the cold frames, to force them forward; begin to force asparagus, and build mushroom-beds.

In the *Flower Garden open ground Department*, plant dried roots of border flowers; transplant biennials, if the weather is fine; protect tender roots by litter and leaves, or tan and ashes. Land up trees with mats or straw, covered with nets. In the routine culture, collect earths, composts, and manures.

In the *Flower Garden Hot-house Department*, glass-case without artificial heat; take care of alpines, annuals, and perennials intended for forcing. Guard against damps by excluding air charged with heavy moisture. In the hot-beds and pits, go on forcing all manner of flowering shrubs, bulbs, and perennial plants. Blow Dutch roots in water glasses. In the greenhouse, the temperature must be 42° at a medium. In the dry stove, the temperature should be 45° or 50° at a maximum. In the bark and moist stove, from 55° to 70° at a maximum.

In the *Pleasure Ground* and *Shrubbery*, plant deciduous trees and shrubs of the hardier kind in dry weather; prune and cut hedges; protect magnolias, Chinese rose-trees; roll, mow, and sweep turf. Prepare for planting, by levelling, digging, trenching, &c.

In the *Nursery Department*, fruit trees must be planted only in mild weather; after the middle of November, it is not proper to meddle with fruit trees till February. Ornamental trees and shrubs may now be planted; the larger seeds of forest trees may be sown: cones, acorns, masts, nuts, keys, and berries for immediate sowings, may now be gathered.

*Permanent Plantations* and *Park Scenery* trees should now be planted in temperate weather; deciduous trees should be pruned, thinned, or felled, according to circumstances. Dead fences of every description, repair or erect; but never build walls in December or January.

NUCLEUS, the *Kernel*, is used by Hevelius, and some other astronomers, for the body of a comet, which others call its head, as distinguished from the tail or beard. Nucleus is also used by some writers for the central parts of the earth and other planets, which they suppose firmer, and separated from the other parts, as the kernel of a nut is from the shell.

NUDE CONTRACT, *Nudum Pactum*, a bare promise without any consideration.

NUISANCE, any thing that does hurt, inconvenience, or damage, to the property or person of another. Nuisances are either public or private, as they affect either the public or the individual. The remedy for a private nuisance is by action on the case for damages, and for a public nuisance by indictment. Amongst the nuisances of most common occurrence are the erecting of noxious manufactures in towns, and in the vicinity of ancient houses; as a vitriol manufactory, to the annoyance of the neighbours in general. Disorderly houses, stage booths, lotteries, and common scolds, are also public nuisances. Where the injury is merely to an individual, and not to the public, the individual only has an action, but not in the case of a public nuisance, where the private injury is merged in that of the public, but where an individual receives a particular injury by a public nuisance. And any one aggrieved may abate, that is, pull down and remove a nuisance, after which he can have no action; but this is a dangerous attempt, to take the law into one's own hands. It must be done without riot, if at all. Every continuance of a nuisance is a fresh nuisance, and a fresh action will lie.

NUL TIEL RECORD, the replication which the plaintiff makes to the defendant, when the latter pleads a matter of record in bar to the action, and it is necessary to deny the existence of such record.

NUMBER, in its extended signification, has reference to every abstract quantity that can be made the subject of arithmetical computation; but, in a more limited sense, it signifies only several things of the same kind, and may be defined a multitude of units. Numbers of this latter kind are termed *integral*, to distinguish them from other numbers, of various denominations; as experimental, fractional, &c.

*Integral* Numbers are distinguished into various classes, as follows: Absolute, Abstract, Abundant, Amicable, Cardinal, Circular, Composite, Concrete, Figurate, Homogeneal, Irrational, Ordinal, Perfect, Polygonal, Prime, Rational, &c.

The *Properties* of Numbers, are certain theorems relating to their Divisors, Forms, Powers, Products, &c. of which the more general are enumerated below;—1. The product of two numbers is the same, whichever of the two is the multiplier. 2. Every integer number, without exception, is composed of, and may be resolved into, different terms of the geometrical series 1, 2, 4, 8, 16, &c. 3. Every integer number, without exception, may be made up by the addition and subtraction of different terms in the series of 1, 3, 9, 27, 81, &c.; and therefore with such a series of weights, any number of pounds may be ascertained. 4. The difference between any cube and its root, is divisible by 6; between any fifth power and its root, is divisible by 10. 5. Every number whatever is the sum of three, or a less number of triangular numbers; of four, or a less number of squares; of five, or a less number of pentagonals; and so on for hexagonals, heptagonals, &c. This theorem has never yet been demonstrated generally.

*Golden* Number. *See* Golden *Number* and Cycle.

Number of *Direction*, in Chronology, some one of the 35 numbers between the Easter limits, or between the earliest and latest days on which Easter can fall, *viz.* between March 22 and April 25, which is 35 days, and is so called because it serves as a direction for finding Easter for any year, being the number that expresses how many days after the 21st of March Easter-day falls. Thus, Easter-day, falling as in the first line below, the number of direction will be as on the lower line.

| | March. |
|---|---|
| Easter-day,.................. | 22,23,24,25,26,27,28,29,30,31 |
| Number of direction, ......... | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 |

| | April. |
|---|---|
| Easter-day,.................. | 1, 2, 3, 4, 5, 6, 7, 8, &c. |
| Number of direction, ......... | 11,12,13,14,15,16,17,18, &c. |

and so on, till the number of direction on the lower line be 35, which will answer to April 25, being the latest that Easter can happen. Therefore add 21 to the number of direction, and the sum will be so many days in March for the Easter-day; if the sum exceed 31, the access will be the day in April.

*To find the Number of Direction.*—Enter the following table with the Dominical Letter on the top, and the Golden Number on the right hand; then where the columns meet is the number of direction required for that year.

| G. N. | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 1 | 29 | 27 | 8 | 19 | 30 | 24 | 25 |
| 2 | 19 | 13 | 14 | 15 | 16 | 17 | 18 |
| 3 | 5 | 6 | 7 | 8 | 2 | 3 | 4 |
| 4 | 26 | 27 | 21 | 22 | 23 | 24 | 25 |
| 5 | 12 | 13 | 14 | 15 | 16 | 10 | 11 |
| 6 | 33 | 34 | 35 | 29 | 30 | 31 | 32 |
| 7 | 19 | 20 | 21 | 22 | 23 | 24 | 18 |
| 8 | 12 | 13 | 7 | 8 | 9 | 10 | 11 |
| 9 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| 10 | 19 | 20 | 21 | 15 | 16 | 17 | 18 |
| 11 | 5 | 6 | 7 | 8 | 9 | 10 | 4 |
| 12 | 26 | 27 | 28 | 29 | 23 | 24 | 25 |
| 13 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 14 | 5 | 6 | 7 | 1 | 2 | 3 | 4 |
| 15 | 26 | 20 | 21 | 22 | 23 | 24 | 25 |
| 16 | 12 | 13 | 14 | 15 | 9 | 10 | 11 |
| 17 | 33 | 34 | 28 | 29 | 30 | 31 | 32 |
| 18 | 19 | 20 | 21 | 22 | 23 | 17 | 18 |
| 19 | 12 | 6 | 7 | 8 | 9 | 10 | 11 |

Thus, for the year 1790, the Dominical Letter being C, and the Golden Number 5; in the column C and the line 5 stands 14, the number of direction; to this add 21, which gives 35, subtract 31, and there remains 4; which is the day of April on which Easter-day fell in the year 1790.

Number, in Grammar, a modification of nouns, verbs, &c. to accommodate them to the varieties in their objects, considered with regard to number.

Numbers, in Poetry, Oratory, Music, &c. are certain measures, proportions, or cadences, which render a verse, period, or song agreeable to the ear.

NUMERAL Figures, or Digits, are those figures by which all numbers are expressed in arithmetic. *See* Notation.

Numeral *Letters* are the seven Roman capitals I. V. X. L. C. D. M. *See* Notation of the *Romans*.

NUMERATION, in Arithmetic, is the art of reading, or estimating, the value of any number expressed by the ten characters 1, 2, 3, &c. anyhow combined or repeated; and is, therefore, the reverse of notation, which is expressing by those characters any number proposed. In order that the nine significant figures may express not only units, but tens, hundreds, thousands, &c. each character has a local value given to it, so that, though when alone they express only units, yet in the second place they denote tens; in the third, hundreds; in the fourth, thousands: thus, 5555 represents five thousands, five hundreds, fifty, and five. Hence, then, to express any written number, or to assign the proper value to each character, beginning at the right hand, divide the proposed number into periods of three places each, and consider two of these as forming one period of six places; then each of these greater periods has a name common to all the figures of which it is composed; the first six being units; the next six, millions; the third, millions of millions, or billions; the fourth, trillions; and so on: also every half period of three places is read separately, or by itself, so many hundreds, tens, and units; only after the left-hand half of each period, the word thousands is repeated; and at the end of each complete period its common name is added: Thus,

4,591, is four thousand, five hundred and ninety-one.

346,718, is three hundred and forty-six thousand, seven hundred and eighteen.

47,671,600, is forty-seven million, six hundred and seventy-one thousand, six hund red.

7,418,467,600,000, is seven billion, four hundred and eighteen thousand, four hundred and sixty-seven million, six hundred thousand.

The French enumerate their numbers in a different manner, calling the first three, hundreds and units; the next three, thousands; the next three, millions; the next three, billions, the next three, trillions, &c.

**Numeration**, or *Notation*, the art of expressing in characters any number proposed in words; or of expressing in words any number proposed in characters.

**Numerator** of a *Fraction*, that number which stands above the line, and shews how many parts the fraction consists of; as the denominator represents the number of parts into which the unit is supposed to be divided.

**NUMERICAL**, or Numeral, something that relates to number.—*Numeral Algebra*, are those cases in which numbers are employed, in contradistinction to *Literal Algebra*, or that in which the letters of the alphabet are made use of.

**NUMIDA**, the *Pintado* or *Guinea Hen*, in Natural History, a genus of birds of the order gallinæ, whose native territory is Africa. It is gregarious, having been often seen in numerous flocks, but now extremely common in this country. The female lays many eggs, and secreting her nest, sometimes will suddenly appear with a family of twenty young ones. It is a bird of harsh sound, which it almost perpetually utters. The flesh of the young birds is valued, and its eggs are thought preferable to those of the common hen.

**NUNCIO**, or Nuntio, an ambassador from the pope to some Catholic prince or state.

**NUNCUPATIVE WILL**, denotes a last will or testament, only verbally, and not in writing.

**NUPHAR**, in Botany, is the yellow water lily, from the flowers of which was anciently prepared a cooling drink. The Turks still make sherbet from these flowers, which give a kind of bitter-almond flavour to the liquor in which they are infused. Class Polyandria, order Monogynia.

**NURSERY**, a piece of land for raising and propagating trees and plants to supply the garden and other plantations. In a nursery for fruit trees, the following rules are to be observed. 1. That the soil should not be better than that in which the trees are to be planted, when removed. 2. It is highly necessary that it be fresh. 3. It ought neither be too wet, nor too dry, but rather of a middling nature, though of the extremes dry is preferred. 4. It must be enclosed in such a manner that neither cattle nor vermin may come in; and to exclude hares and rabbits. 5. The ground being enclosed, should be carefully trenched two feet deep, in August. In trenching the ground, cleanse it from the roots of all noxious weeds. 6. The season being come for planting, level down the trenches about the beginning of October, and then lay out the ground into quarters, which may be laid out in beds for a seminary, in which you may sow the seeds or stones of fruit. 7. And having provided yourself with stocks, the next year proceed to transplant them: draw a line across the ground, and open a number of trenches exactly straight; then take the stocks out of the seed-beds; in doing which you should raise the ground with a spade, in order to preserve the roots as entire as possible; prune off the very small fibres; and if there are any that have a tendency to root directly downwards, such roots should be shortened. Then plant them in the trenches, if they are designed for standards, in rows three feet and a half or four feet from each other, and a foot and a half distant in rows; but if for dwarfs, three feet row from row, and one foot in the row, will be a sufficient distance. These plants should not be headed or pruned at top. If the winter should prove very cold, lay some mulch on the surface of the ground near their roots, taking care not to let it lie too thick near the stems of the plants, and to remove it as soon as the frost is over. In the summer season destroy the weeds, and dig up the ground every spring between the rows. *See* Grafting. As to timber trees, nurseries should be made upon the ground intended for planting, where a sufficient number of the trees may be left standing, after the others have been drawn out to plant in other places.

**NUT**, in Vegetable Physiology, is a hard and bony seed, not opening by valves, but usually consisting of one cell and kernel.

**NUTATION**, in Astronomy, is a tremulous motion of the earth's axis, through which its inclination to the plane of the ecliptic undergoes some changes. This phenomenon was first observed by Dr. Bradley, who published an account of his discovery in 1717. The period of these variations is nine years.

**NUTGALLS**, are excrescences formed on leaves of the oak by the puncture of an insect, which deposits an egg on them. The best are the Aleppo galls of commerce, imported for the use of dyers, calico printers, &c.

**NUTMEG**, the kernel of a large fruit, not unlike the peach, the produce of the Miristica, which see. The nutmeg is separated from its investient coat, the mace, before it appears in commerce. The nutmeg, as we receive it, is of a roundish or oval figure, of a tolerably compact and firm texture, but easily cut with a knife, and falling to pieces on a smart blow. Its surface is not smooth, but furrowed with a number of wrinkles, running in various directions, though principally longitudinally. It is of a greyish brown colour on the outside, and of a beautiful variegated hue within. It is very unctuous and fatty to the touch when powdered, of an extremely agreeable smell, and of an aromatic taste, without the heat that attends that kind of flavour in most of the other species. The largest, heaviest, and most unctuous are to be preferred, such as are the shape of an olive, and of the most fragrant smell.

**NUX VOMICA**, the seed of the officinal strychnos, a native of the East Indies. It is about an inch broad, and nearly a quarter of an inch thick, covered with a kind of woolly matter; internally it is tough and hard, like horn, to the taste extremely bitter, but having no remarkable smell; it consists chiefly of a gummy matter, the resinous part being very inconsiderable. Nux vomica, reckoned amongst the most powerful poisons of the narcotic kind, proves fatal to dogs in a very short time. Loureiro relates that a horse died in a quarter of an hour after taking an infusion in wine of the seeds in a half-roasted state. It is employed to stupify fishes in a fish pond, when they come to the surface and are easily taken.

**NYMPH**, among naturalists, that state of winged insects between their living in the form of a worm and their appearing in the winged or most perfect state.

**NYL GHAU**, in Zöology, an animal between the deer and the ox, swift of foot, and remarkably strong. The first pair were sent from Bombay to England in the year 1767, as a present to Lord Clive.

**NYMPHÆA**, Water Lily, a genus of the polyandria monogynia class and order, of which there are six species: 1. and 2. The lutea and alba, or yellow and white water lilies; natives of Britain, growing in lakes and ditches. Linnæus tells us that swine are fond of the leaves and roots of the former, and that the smoke of it will drive away crickets and battæ, or cockroaches, out of houses. The roots of the second have an astringent and bitter taste, and are used to dye dark brown. 3. The lotus, with heart-shaped toothed leaves, a plant thought peculiar to Egypt, is mentioned by Herodotus and Savary, as growing in the rivulets, and on the sides of the lakes; there are two sorts or varieties of this plant, the one with a white the other with a bluish flower. The calyx blows like a large tulip, and diffuses a sweet smell resembling that of the lily. The first species produces a round root like that of a potato, and the inhabitants of the banks of the lake Menzall feed upon it. 4. In the East and West Indies grows a species of this plant, named nelumbo by the inhabitants of Ceylon; the flowers, large and flesh coloured, consist of numerous petals, disposed in two or more rows; and are held sacred among the Hindoos. It is divided into several distinct cells, which form so many large round beds upon the surface of the fruit, each containing a single seed.

**NYMPHÆA** Alba, and Lutea. These are aquatics, and scarcely any plant is more deserving of our attention. The fine appearance of the foliage floating on the surface, which is interspersed with beautiful flowers, will render any piece of water very interesting: it should also be observed, that gold fish are found to thrive best when they have the advantage of the shade of these plants. It is difficult in deep water to make them take root, being liable to float on the surface, in which state they will not succeed. But if the plants are placed in some strong clay or loam, tied down in wicker baskets, and then placed in the water, there is no fear of their success: they should be placed where the water is sufficiently deep to inundate the roots two feet, or a little more.

# O.

O, or o, the fourteenth letter, and fourth vowel, of our alphabet, pronounced as in the words *nose*, *rose*, &c. As a numeral, O is sometimes used for eleven; and with a dash over it, thus, $\bar{O}$, for eleven thousand. In music, the O, or rather a circle or double CƆ, is a note of time called by us a semi-breve; and by the Italians circolo. The O is also used as a mark of triple time, as being the most perfect of all figures.

OAK, in Botany, is a well-known tree, styled by way of eminence, the "lord of the forest." In Ampthill Park, the residence of the late Lord Ossory, now that of Lord Holland, stands one of those magnificent monarchs of the wood,—a particularly large oak. The circumference of its base is upwards of forty feet; its middle girt is about thirty: it is quite hollow, forming a concavity sufficient to contain four or five middle-sized persons standing together withinside. The chief of its branches, which is much greater in dimension than many parent oaks, is supported by a couple of large wooden props, on account of its weight being too great to be kept up by the main body of the tree. There are many fine oaks in numerous other parts of the empire; as in Salecy forest, Northamptonshire, and in the Duke of Hamilton's park in Lanarkshire. The wood of this tree is one of the most durable that grows; and its use in naval and domestic purposes is exceedingly great. The bark is used in tanning, and after this office is performed, one load of it will do more service to stiff cold land than two loads of the richest manure. For hotbeds also oak bark is in great request; but its powerfully astringent properties render it useless for medical purposes. Before oak-timber is in a state to be used, it is requisite that the trees should be barked, and suffered to stand uncut for three or four years, that they may become perfectly dry. The sawdust of this tree, and even the leaves, though much inferior to the bark, have been found useful in tanning. The former of these is the principal vegetable production of this country, which is used in the dyeing of fustian; all the various shades of drab and brown are made with oak sawdust, differently managed and compounded.

OAKUM, the substance into which old ropes are reduced when they are untwisted, loosened, and drawn asunder. It is principally used in caulking the seams, tree-nails, and bends of a ship, for stopping or preventing leaks.

OAR, a long piece of timber, flat at one end, and round or square at the other, used to make a vessel advance upon the water. The flat part which is dipped into the water is called the blade, and that which is within the board is termed the loom, whose extremity being small enough to be grasped by the rowers, is called the handle. To push the boat or vessel forwards by means of this instrument, the rowers turn their backs forwards, and dipping the blade of the oar in the water, pull the handle forward, so that the blade at the same time may move aft in the water. But since the blade cannot be so moved without striking the water, this impulsion is the same as if the water were to strike the blade from the stern towards the head: the vessel is therefore necessarily moved according to the direction. Hence it follows, that she will advance with the greater rapidity, by as much as the oar strikes the water more forcibly; consequently an oar acts upon the side of a boat or vessel like a lever of the second class, whose fulcrum is the station upon which the oar rests on the boat's gunwale. In large vessels this station is usually called the row port, but in lighters and boats it is always termed the row-lock. Oars for ships are generally cut out of fir timber; those for barges are made out of New England or Dantzic rafters; and those for boats, either out of English ash, or fir rafters from Norway. *To Boat the* OARS, is to cease rowing, and lay the oars in the boat. *Get your* OARS *to pass*, the order to prepare them for rowing. *To Ship the* OARS, is to place them in the row-locks, as *To Unship them*, is to take them out of the row locks, and is frequently practised in passing very near a vessel, to prevent breaking the oars, &c.

OATH, an affirmation or promise, accompanied with an invocation of God to witness what we say, and with an imprecation of his vengeance, or a renunciation of his favour, if what we affirm be false, or what we promise be not performed. Hence oaths are either *assertory* or *promissory*. Quakers and Moravians, interpreting the scriptures according to their own judgments, refuse to swear before any magistrate, or in any court; and our justices and judges, with a degree of liberality which many condemn, allow the Quaker and Moravian to affirm upon their bare word what another religionist would be required to swear to.

OATS, are the seeds or grain of an annual plant, too well known, and too much cultivated throughout every part of Europe, to need any description. The country from whence they were originally imported is not known. The principal use of oats in this country is for the feeding of horses. In the northern parts of England, and in Scotland, they are applied also to the nutriment of man. When simply freed from their husks, they are called *groats* or *grits;* in this state they are much used in broths, and other kinds of nutriment for the sick and infirm. More frequently, however, they are ground into oatmeal, which is made into cakes, biscuits, &c. The husks infused in water, and allowed to remain till the water becomes somewhat acid, are boiled to a jelly called *sowins*. A grateful and nutritive kind of jelly, which has the name of *flummery*, is also made of oatmeal, boiled with water, and flavoured with a little orange-flower water, and sugar. Oats will thrive in almost any soil, but are chiefly productive on land newly broken up. They are usually sown in February, and the harvest commences about August. Several kinds or varieties are cultivated in different parts of England, such as white oats, black oats, brown or red oats, Tartarian or reed oats, Friesland oats, Poland oats, and some others; but of these the first are considered the most valuable.

OAT *Grass*, the name of a coarse grass that in some particular soils may be cultivated to some advantage.

OAT, *Wild*, a species of grain, considered by agriculturists as a weed, which cannot, without much difficulty, be eradicated from a soil of which it has once taken possession. The seed will retain its germinating power for many years in the ground, and spring forth when preparations are made for other crops. Cutting in an unripe state seems to be the only way to ensure its extirpation.

OBEAH, a species of witchcraft practised among the negroes, the apprehensions of which operating upon their superstitious fears, is frequently attended with disease and death.

OBELIAS, small cakes used among the ancients, which, toasted on small spits, and dipped in wine, were eaten as desserts.

OBELISCUS MARMOREUS. In Natural History, this name is given to a remarkable species of shell fish, but never found alive in modern times. In a fossil state it is frequently seen in Swedish stone, used for pavements, and some other purposes.

OBELISK, in Architecture, a truncated, quadrangular, and slender pyramid, raised as an ornament, and frequently enriched with inscriptions in bas-relief, or hieroglyphics.

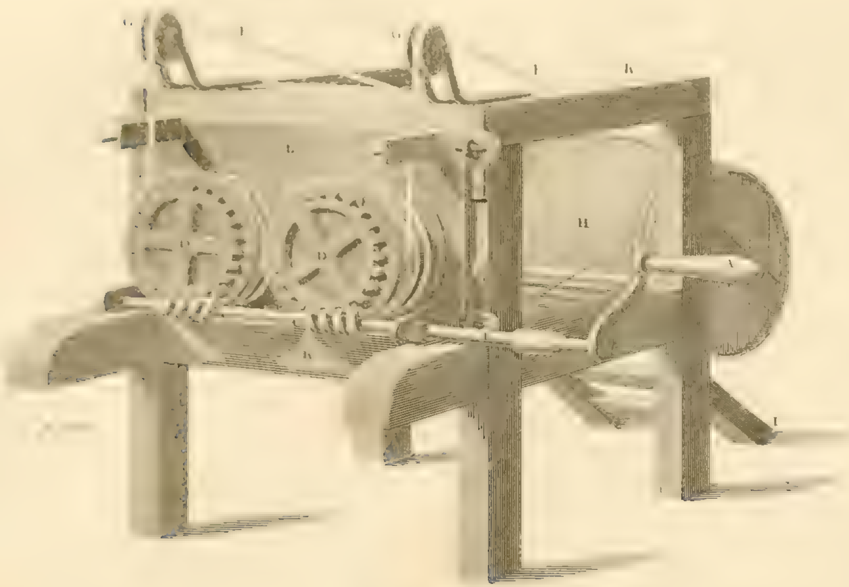
OBITUARY, a funeral register, in which are written the names of the dead.

OBJECT GLASS, in Optical Instruments, is that which is placed towards the object, the other extreme lens being called the eye-glass, being that to which the eye is directed.

OBJECTIVE LINE, in Perspective, is any line drawn on the geometrical plane, the representation of which is sought in the draught or picture.

OBLATA, things offered voluntarily to kings by their subjects.

OBLATE, *Flattened*, or *Shortened*, having its axis shorter than its middle diameter, being formed by the rotation of an ellipse about the shorter axis. The earth is an oblate spheroid, the polar diameter being shorter than the equatorial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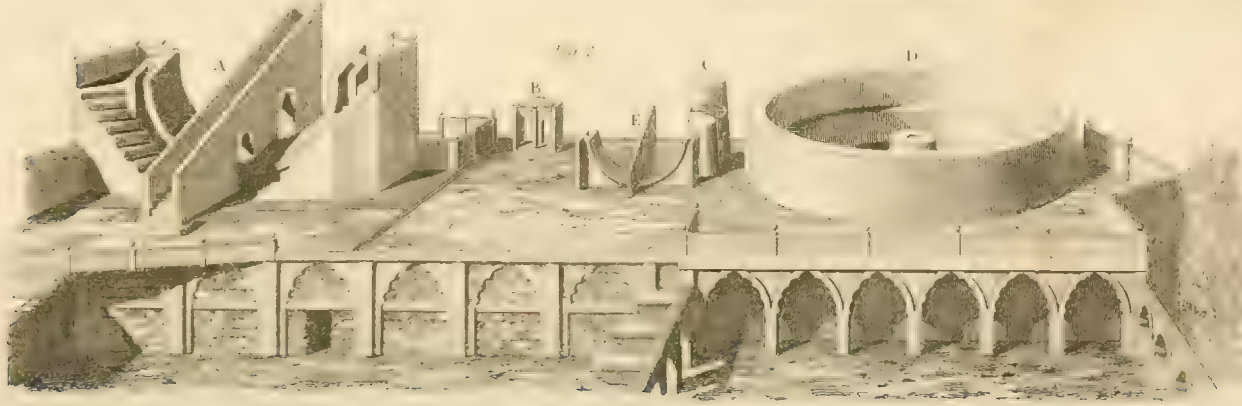
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diameter, in the proportion of 331 to 332: that is to say, the polar diameter is 7900 miles, and the equatorial diameter 7924 miles.

**OBLATI**, secular persons who bestowed themselves and estates on some monastery, for which they were admitted as lay brothers.

**OBLATIONS**; these primarily denoted things offered to God either through the church, or the priests. The term is now used in a less restricted sense.

**OBLIGATION**, a bond containing a penalty, with a condition annexed, either for payment of money, performance of covenant, or the like.

**OBLIGER**, in Law, he who enters into an obligation; as obligee the person to whom it is entered into.

**OBLIQUE**, in Geometry, something slant, or inclining from the perpendicular, as *oblique* ascension, *oblique* circle, *oblique* descension, *oblique* planes, in Dialing; *oblique* sailing, in Navigation. *See* these several words.

**OBLONG**, in Geometry, a figure that is longer one way than another, as one of the columns of this page of paper; which takes the form of a parallelogram.

**OBOLARIA**, a genus of plants belonging to the didynamia class, and ranking under the 40th order, Personatæ.

**OBOLUS**, in Antiquity, an ancient Athenian coin, worth a penny farthing. In medicine, *obolus* signifies a weight of ten grains, or half a scruple. Among the Sicilians, *obolus* denotes a weight of one pound.

**OBRINE**, knights of a military order, instituted in the 13th century by Conrade.

**OBSERVATION**, in Astronomy and Navigation, denotes the measuring with some proper instrument for the purpose, the angular distance, altitude, &c. of the sun, moon, or other celestial body.

**OBSERVATORY**, OBSERVATORIUM, a place destined for observing the heavenly bodies; or a building usually in form of a tower, raised on some eminence, and covered with a terrace for making astronomical observations. The more celebrated observatories are, 1. The Greenwich Observatory, or Royal Observatory of England, was built in 1676, by order of Chas. II. at the solicitation of Sir Jonas Moore and Sir C. Wren, and furnished with the most accurate instruments by the same, particularly a noble sextant of seven feet radius, with telescopic sights. The province of observing was first committed to Flamstead, a man who seemed born for the employment. For fourteen years, with unwearied pains, he watched the motions of the planets, and particularly those of the moon, as was given him in charge; that a new theory of that planet being found, exhibiting all her irregularities, the longitude might thence be determined. In the year 1690, having provided himself with a mural arch of seven feet diameter, well fixed in the plane of the meridian, he verified his catalogue of the fixed stars, (which hitherto had depended altogether on the distances measured with the sextant,) after a new and very different manner, *viz.* by taking the meridian altitudes, and the movements of culmination, or the right ascension and declination. With this instrument he was so pleased, that he laid the use of the sextant almost wholly aside; and in this way was the astronomer royal employed for thirty years; in the course of which time nothing had appeared in public worthy so much expense and preparation; so that the observer seemed rather to have been employed for his own sake, and that of a few friends, than for the public; though it was notorious the observations that had been made were very numerous, and the papers swelled to a great bulk. This occasioned Prince George of Denmark, in 1704, to appoint certain members of the Royal Society, *viz.* the Hon. Fr. Robarts, Sir C. Wren, Sir Isaac Newton, Dr. Gregory, and Dr. Arbuthnot, to inspect Flamstead's papers, and select such as they should think fit for the press, purposing to print them at his own expense; but the prince dying before the impression was half finished, it lay still for some time; till at length it was resumed by order of Queen Anne, and the care of the press committed to Dr. Arbuthnot; and that of correcting and supplying the copy to Dr. Halley. Such was the rise and progress of the "Historia Cœlestis;" the principal part whereof is the catalogue of fixed stars, called also the Greenwich Gatalogue. Flamstead was succeeded by Dr. Halley; and Dr. Halley, in 1742, by Dr Bradley, so deservedly celebrated for his discovery of the aberration of the stars, and the nutation of the earth's axis, after Dr. Bradley, the appointment was, in 1762, conferred upon Mr. Bliss, who was succeeded in 1785 by Dr. Maskelyne, the late worthy astronomer royal; upon whose demise, in 1811, this important office was conferred upon Mr. Pond.

The Greenwich observatory is found, by very accurate observation, to lie in 51° 28′ 30″ north latitude.

2. The French Observatory, built by Louis XIV. in the Fauxbourg St. Jaques, Paris, is a very singular, but withal, a very magnificent building. It is eighty feet high, and at the top there is a terrace. It is here M. de Lahire, M. Cassini, &c. have been employed. This observatory was begun in 1664, and finished in 1672. The difference in longitude between this and Greenwich Observatory is 2° 20 15″ each. In the Paris Observatory is a cave, or cellar, of one hundred and seventy feet descent, for making various experiments, particularly such as relate to congelations, refrigerations, indurations, conservations, &c. And in this cave there is a thermometer of M. de Lahire, which is always at the same height, indicating the temperature of the place to be always the same.

3. Tycho Brahe's Observatory in the little island Ween, or the Scarlet Island, between the coasts of Schonen and Zealand in the Baltic, was erected, and furnished with instruments, at his own expense; and was called by him Uraniburgh. In this place he spent twenty years in observing the stars.

We may enumerate here some other observatories, as that of Pekin, erected by a late emperor of China in his capital, upon the recommendation of the Jesuit missionaries; and that of the Bramins at Benares, in the East Indies, of which we give an engraving, (see plate OBSERVATORY) representing and illustrating several particulars, as in the following description:—

The observatory at Benares, built by order of the emperor Ackbar, was once a magnificent structure; the lower part of it is now, however, converted into stables; the court yards and apartments are still spacious. It stands on the banks of the Ganges, and the summit is approached by a staircase leading to a large terrace, where numerous instruments still remain in great preservation, stupendously large, immoveable from the spot, and built of stone, some of them being upwards of twenty feet in height. Their graduation is very exact.

The situation of the two large quadrants, marked A in the plate, whose radius is nine feet two inches, by their being at right angles with a gnomon at 25° elevation, shew the stability and excellence of the architecture. The three sights on this gnomon occupy a space of 38½ feet, and they are perfectly true. The quadrants, 20 feet in diameter, are built in perpendicular ovals, that follow the meridian of the place. The arcs of those quadrants are graduated into nine parts, and each of these again into ten parts $=$ 90° in all.

Figure A is properly an equinoctial sun-dial, that expresses solar time by the shadow of a gnomon upon two quadrants, one east and the other west of it. Fig. B is an instrument for determining the exact hour of the day by the shadow of a gnomon, which stands perpendicular to, and is in the centre of, a flat circular stone, supported in an oblique position by four upright stones and a cross piece, so that the shadow of the gnomon, which is a perpendicular iron rod, is thrown upon the division of the circle described on the face of the flat circular stone.

Figure C is a brass circle, about two feet diameter, moving vertically upon two pivots between two stone pillars, having an index or hand turning round horizontally on the centre of this circle, which is divided into 360 parts. This is in fact an azimuth instrument; since its use is to measure on what point of the horizon any celestial body may rise or set.

Figure D consists of two circular walls, the outer one forty feet diameter and eight feet high, and the inner wall, half that height, appears to be a parapet, from which to observe the divisions on the upper circle of the outer wall. Both circles are divided into 360 equal parts, each divided into 20 lesser divisions. In this inner circle is a pillar exactly in its centre, in which a perpendicular rod has been once placed.

Figure E is a small equinoctial sun-dial, constructed similarly to fig. A.

The principal instruments for a fixed observatory are, a large fixed quadrant or a circular divided instrument, chiefly for measuring vertical angles; a transit instrument; an equatorial instrument; a chronometer, or regulator; one or more powerful telescopes; a fixed zenith telescope, and a night telescope. The quadrant or quarter of a circle, divided into 90 degrees, and each degree subdivided into minutes or smaller parts, has been made of various sizes; some of them having a radius even of eight or nine or more feet in length. When those quadrants do not exceed one or two, or at most three, feet, in radius, they are generally fixed upon their particular stands, which are furnished with various mechanical contrivances, that are necessary to place the plane of the quadrant perpendicular to the horizon, and for all the other necessary adjustment. But large quadrants are fixed upon a strong wall. *See* QUADRANT.

The transit instrument consists of a telescope of any convenient length, fixed at right angles to a horizontal axis, which axis is supported at its two extremities; and the instrument is generally situated so that the line of collimation of the telescope may move in the plane of the meridian. The use of this instrument is to observe the precise time of the celestial bodies' passage across the meridian of the observatory. *See* TRANSIT INSTRUMENT.

*To adjust the Clock by the Sun's transit over the Meridian.* Note the times by the clock when the preceding and following edges of the sun's limb touch the cross wires. The difference between the middle time and 12 hours shews how much the mean or time by the clock is faster or slower than the apparent or solar time for that day: to which the equation of time being applied, will shew the time of mean noon for that day, by which the clock may be adjusted.

Astronomical or equatorial sector, an instrument for finding the difference in right ascension and declination between two objects, the distance of which is too great to be observed by the micrometer, was invented by Graham. *See* EQUATORIAL.

*Equatorial or Portable Observatory*, an instrument designed to answer a number of useful purposes in practical astronomy, independently of any particular observatory; it may be made use of in any steady room, and performs most of the useful problems in the science. The principal uses of this equatorial are:

1. To find the meridian of one observation only: for this purpose elevate the equatorial circle to the co-latitude of the place, and set the declination semi-circle to the sun's declination for the day and hour of the day required; then move the azimuth and hour circles both at the same time, either in the same or contrary directions, till you bring the centre of the cross hair in the telescope exactly to cover the centre of the sun; when that is done, the index of the hour circle will give the apparent or solar time at the instant of observation; and thus the time is gained, though the sun is at a distance from the meridian; then turn the hour circle till the index points precisely at 12 o'clock, and lower the telescope to the horizon, in order to observe some point there in the centre of your glass, and that point is your meridian mark found by one observation only; the best time for this observation is three hours before or three hours after twelve at noon.

2. To point the telescope on a star though not on the meridian, in full day-light. Having elevated the the equatorial circle to the co-latitude of the place, and set the declination semicircle to the star's declination, move the index of the hour circle till it shall point to the precise time at which the star is then distant from the meridian, found in tables of the right ascension of the stars, and the star will then appear in the glass.

Besides these uses peculiar to this instrument, it is also applicable to all the purposes to which the principal astronomical instruments, *viz.* a transit, a quadrant, and an equal altitude instrument, are applied.

Of all the different sorts of chronometers or time-keepers, a pendulum clock, when properly constructed, is undoubtedly capable of the greatest accuracy; therefore, such machines are most recommendable for an observatory. The situation of this clock must be near the quadrant, and near the transit instrument; so that the observer, whilst looking through the telescope of any of those instruments, may hear the beats of the clock, and count the seconds.

A pretty good telescope placed truly vertical in an observatory, is likewise a very useful instrument, as the aberration of the stars, and latitude of the place, may be observed and determined by the use of such an instrument, with great ease and accuracy. *See* TELESCOPE.

The night telescope is a short telescope, which magnifies very little; but it collects a considerable quantity of light, and has a very great field of view; it therefore renders visible several dim objects, which cannot be discovered with telescopes of considerably greater magnifying powers; and hence it is very useful for finding out nebulæ, or small comets, or to see the arrangement of a great number of stars in one view.

The principal instruments that are at present used for marine astronomy, or for the purposes of navigation, are, that incomparably useful instrument called Hadley's sextant or quadrant, or octant; a portable chronometer; and a good telescope.

**OBSIDIAN**, a volcanic glass, resembles lumps of black glass. Its surface is smooth, it is hard, and strikes fire with steel. It is common in the neighbourhood of volcanoes, and in some basalts, probably the products of volcanic fires now extinguished. In Lipari, one of the volcanic isles, the mountain de la Castagna, according to Spalanzani, is wholly composed of volcanic glass, which appears to have flowed in successive currents like streams of water falling with a rapid descent, and suddenly frozen. This glass is sometimes compact, and sometimes porous and spungy. Obsidian appears to be lava suddenly cooled; if a mass of lava or basalt be exposed to the heat of a glass furnace, it melts into a shining black or greenish black glass. Numerous veins of obsidian are said to intersect the cone of Mount Vesuvius, and serve as a cement to keep together the loose materials of which it is composed. Obsidian is sometimes ground and polished, and used for mirrors.

**OBSIDIANUS LAPIS**, in the natural history of the ancients, was the name of a stone sometimes called China marble. It is black, smooth, hard, difficult to cut, capable of receiving a fine polish, and was used among the Greeks for the making of reflecting mirrors. In Peru, at the time of its conquest by the Spaniards, the inhabitants used it for mirrors, and in Europe it has been converted into reflectors for telescopes.

**OBSTRUCTION**, in Medicine, such an obturation of the vessels as prevents the circulation of the fluids, whether of the food and vital, or of the morbid and peccant kind, through them.

**OBTUSE**, literally implies any thing blunt or dull, in contradistinction to acute, sharp, or pointed.

OBTUSE *Angle*, *Angular Section*, *Cone*, *Hyberbola*, &c.

**OCCATION.** In ancient husbandry this term was nearly synonymous with our modern harrowing, though the instrument employed was a kind of rake.

**OCCIDENT**, in Astronomy and Geography, is the same as westward, or point of the horizon where the sun sets. A planet is said to be occident when it sets after the sun.

OCCIDENT, *Equinoctial*, that point of the horizon where the sun sets when he crosses the equinoctial, or enters the sign Aries or Libra.

OCCIDENT, *Estival*, that point of the horizon where the sun sets at his entrance into the sign Cancer.

OCCIDENT *Horizon*. *See* HORIZON.

OCCIDENT, *Hybernal*, that point where the sun sets when he enters the sign Capricorn.

**OCCULT** LINE, in Geometry, a dry or obscure line, which is drawn as a necessary part of the construction of a figure or problem, but which is not intended to appear after the plan is finished.

OCCULT, something hidden or secret; as the occult qualities of bodies.

**OCCULTATION**, the obscuration of a planet or star by the interposition of the moon, or other planet, between it and our eye.

**OCCUPANCY**, in Law, the taking possession of things which before belonged to nobody. This is the foundation of property. Hence,

**OCCUPANT**, in Law, is the person who first seizes, or gets possession of a thing. And,

**OCCUPATION**, in Law, is use or tenure, trade or mystery.

**OCEAN**, the *Sea*, that mighty element, which occupies more than two-thirds of the terraqueous globe. In the Northern hemisphere, the land bears to the water the proportion of 419 to 1000; or nearly one half; but in the Southern hemisphere only of 129 to 1000; so that the whole mass of land is to that of sea, as 274 to 1000. And almost the whole of this vast body of water is collected in one immense basin called the Southern ocean.

*Division of the waters into Oceans, Seas, Lakes, Straits, Gulfs, Bays or Creeks, Rivers, &c.*—The waters are divided into three extensive oceans, (besides lesser seas, which are only branches of these,) *viz.* the Atlantic, the Pacific, and the Indian ocean. The Atlantic, or Western ocean, 3000 miles wide, divides the eastern and western continents. The Pacific, 10,000 miles over, divides America from Asia. The Indian ocean lies between the East Indies and Africa, being 3000 miles wide. The geographical definition of the *ocean* is a great and spacious collection of water, without any entire separation of its parts by land; as the Atlantic ocean. The *sea* is a smaller collection of water, which communicates with the ocean, confined by the land; as the Mediterranean and the Red sea. A *lake* is a large collection of water, entirely surrounded by land; as the lake of Geneva, and the lakes in Canada. A *strait* is a narrow part of the sea, restrained or lying between two shores, and opening a passage out of one sea into another; as the strait of Gibraltar, or that of Magellan. This is sometimes called a *sound;* as the strait into the Baltic. A *gulf* is a part of the sea running up into the land, and surrounded by it, except at the passage whereby it is communicated with the sea or ocean. If a gulf be very large, it is called an inland sea; as the Mediterranean: if it do not go far into the land, it is called a *bay*, as the Bay of Biscay: if it be very small, a *creek, haven, station*, or *road* for ships, as Milford Haven. Rivers, canals, brooks, &c. need no description: for these lesser divisions of water, like those of land, are to be met with in most countries, and every one has a clear idea of what is meant by them. But in order to strengthen the remembrance of the great parts of the land and water we have described, it may be proper to observe, that there is a strong analogy or resemblance between them.

*On the Saltness of the Sea.*—Sea water is salt, while that of rivers is mild, fresh, sweet, and fit for human purposes. Some think that this saltness arises from great beds of salt lying at the bottom of the sea. But others more rationally suppose it is owing to the following cause. Salt is one of the original principles of nature, and is mixed, in greater or less quantities, with most other bodies. Now all rivers run into the sea, and carry some salt with them; but no rivers run out of it, nor is any water taken from it, except by exhalation or evaporation. But chemists have demonstrably proved, that no salt can ascend in either of these ways; and consequently, all the salt carried into the sea by the immense numbers of rivers that run into it, remains behind, and occasions its saltness. That no salt ascends from the sea, either by exhalation or evaporation, is evident from this, that rain-water, which falls from the clouds, and which was originally exhaled from the sea, is, of all kinds of water, the sweetest, purest, and lightest, and is made the standard by which philosophers judge of all other waters. The water of the ocean contains about the 30th part of its weight of salt: the water of the Baltic holds only from the 200dth to the 100dth part, consequently the water of the Baltic ought to stand 1-40th part higher from the bottom of the sea, than the water of the ocean, in order to maintain its hydrostatic equilibrium. It is observed on the Baltic shores, that the water subsides, and that its surface is lower in all parts than it formerly was. May not this be in consequence of the Baltic becoming salter, and thus approximating to the specific gravity and height of the ocean? *See* TIDES.

The *Currents* of the ocean come next to be considered. Currents are certain progressive movements of the sea, by which all bodies floating therein are compelled to alter their course or velocity, or both, and submit to the laws imposed upon them by the current. The setting of a current is that point of the compass towards which the waters run, and the drift of the current is the rate it runs at in an hour. Currents in the sea are either natural or general, as arising from the diurnal revolution of the earth on its axis; or accidental, and particularly caused by the waters being driven against promontories, or into gulfs and straits, where, wanting room to spread, they are driven back, and thus disturb the ordinary flux of the sea.

The following observations are made by Varenius:—"Currents are various, and directed towards differents parts of the ocean, of which some are constant and others periodical. The most extraordinary current of the sea, is that by which part of the Atlantic or African ocean moves about by Guinea, from Cape Verd, towards the curvature or bay of Africa, which they call Fernando Po, *viz.* from west to east, contrary to the general motion. And such is the force of this current, that when ships approach too near the shore, it carries them violently towards the bay, and deceives the mariners in their reckoning. There is a great variety of shifting currents, which do not last, but return at certain periods; and these do, most of them, depend upon and follow the anniversary winds or monsoons, which by blowing in one place may cause a current in another. At Java, in the straits of Sunda, when the monsoons blow from the west, *viz.* in the month of May, the currents set to the eastward, contrary to the general motion. Also between the island of Celebes and Madura, when the western monsoons set in, *viz.* in December, January, and February, where the winds blow from the north-west, or between the north and west, the currents set to the south-east, or between the south and east. At Ceylon, from the middle of March to October, the currents set to the southward, and in the other parts of the year to the northward: because at this time the southern monsoons blow, and at the other the northern. Between Cochin-china and Malacca, when the western monsoons blow, *viz.* from April to August, the currents set eastward against the general motion, but the rest of the year set westward; the monsoon conspiring with the general motion. They run so strongly in those seas, that inexperienced sailors mistake them for waves that beat upon the rocks, known by the name of breakers. So for some months after the 15th of February, the currents set from the Maldives towards India on the east, against the general motion of the sea. On the shore of China and Cambodia, in the months of October, November, and December, the currents set to the north-west, and from January to the south-west, when they run with such a rapidity of motion about the shoals of Parcel, as to seem swifter than an arrow. At Pulo Condore, upon the coast of Cambodia, though the monsoons are shifting, yet the currents set strongly towards the east, even when they blow to a contrary point. Along the coasts of the bay of Bengal as far as the Cape Romania, at the extreme point of Malacca, the current runs southward in November and December. When the moonsoons blow from China to Malacca, the sea runs swiftly from Pulo Cambi to Pulo Condore, on the coast of Cambodia. In the bay of Sans Bras, not far from the Cape of Good Hope, there is a current particularly remarkable, where the sea runs from east to west to the landward; and this more vehemently, as it becomes opposed by the winds from a contrary direction. The cause is undoubtedly owing to some adjacent shore, which is higher than this."

These currents constantly follow the winds, and set to the same point with the monsoon or trade-wind at sea. Under the equator, where the motion of the earth is the greatest, the currents are so violent, that they carry vessels very speedily from Africa to America; but absolutely prevent their return the same way; so that the ships are forced to run as far as the fortieth degree of latitude, to find a passage into Europe. The currents in the straits of Gibraltar almost constantly drive to the eastward, and carry ships into the Mediterranean: they are also usually found to drive the same way in St. George's Channel. The great violence and danger of the sea in the straits of Magellan, is attributed to two contrary currents setting in, one from the south and the other from the north sea.

Currents, as they relate to navigation, may be defined as certain progressive motions of the water of the sea in several places; by which a ship may happen to be carried forward more swiftly, or retarded in her course, according to the direction or setting of the current in with or against the course or way of the ship. The setting or progressive motion of the current, may be either quite down to the bottom, or to a certain determinate depth. As the knowledge of the direction and velocity of currents is a very material article in navigation, it is highly necessary to discover both, in order to ascertain the ship's situation and course with as much accuracy as possible. This, some do by the ripplings of the water, and by the driving of the froth along the shore, when in sight of it; but the most successful method which has been hitherto attempted by mariners, is the following:—A common iron pot, which may contain four or five gallons, is suspended by a small rope, fastened to its ears or handles, so as to hang directly upright, as when placed upon the fire. This rope, which may be from 70 to 100 fathoms in length, being prepared for the experiment, is coiled in the boat, which is hoisted out of the ship at a proper opportunity, when there is little or no wind to ruffle the surface of the sea. The pot being then thrown overboard into the water and immediately sinking, the line is slackened till about 70 or 80 fathoms run out, after which the line is fastened to the boat's stern, by which she is accordingly restrained, and rides as at anchor. The velocity of the current is then easily tried by the log and half-minute glass, the usual method of discovering the rate of a ship's sailing at sea. (*See* CALM.) The course of the stream is next obtained by means of the compass provided for this operation. This shews whether there be any current or no; and if any, which way it sets, and at what rate it drives: observing, however, to add something to the drift, for the boat's drift, for though she appear to stand still, yet, in reality, she is found to move. This addition experience has thus determined; if the line she rides by be 60 fathom, a third part of the drift is to be added, if 80 fathom a fourth, if 100 fathom a fifth.

If a ship sail along the direction of the current, it is evident the velocity of the current must be added to that of the vessel: if her course be directly against the current, it must be subtracted: if she sail athwart the current, her motion will be compounded with that of the current; and her velocity augmented or retarded according to the angle of her direction with that of the direction of the current: *i. e.* she will proceed in the diagonal of the two lines of direction, and will describe or pass through that diagonal in the same time wherein she would have described either of the sides by the separate forces. Hence it is plain, 1. If the velocity of the current be less than that of the ship, then the ship will advance so much as is the difference of these velocities. 2. If the velocity of the current be more than that of the ship, then will the ship fall as much astern as is the difference of these velocities. 3. If the velocity of the current be more than that of the ship, then will the ship remain stationary, the one velocity destroying the other. If the current thwarts the course of a ship, it not only diminishes or increases her velocity, but gives her a new direction, compounded of the course she steers, and the setting of the current.

Under-currents, are distinct from the upper or apparent, and in different places set or drive a contrary way. Dr. T. Smith makes it highly probable, that in the Downs, in the straits of Gibraltar, &c. there is an under-current, whereby as much water is carried out as is brought in by the upper current. This was confirmed by an experiment made in the Baltic sound, by the seamen on board one of the king's frigates: they went with the pinnace into the midstream, and were carried violently by the current. Soon after that, they sunk a basket with a large cannon bullet, to a certain depth of water, which gave check to the boat's motion; and sinking it still lower and lower, the boat was driven ahead to the windward, against the upper current, the current aloft not being above four or five fathom deep, and the lower the basket was let down, the stronger the under-current was found. Dr. Halley solves the currents setting in at the straits without overflowing the banks, by the great evaporation, without supposing any under-current.

OCELOT, in Zöology, the Mexican cat, the Felis Pardalis of Linnæus.

OCHNA, a genus of plants belonging to the polyandria class, and in the natural order ranking with those whose order is doubtful.

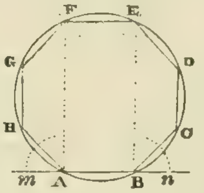
OCHRA, in Ornithology, the name of a species of *moor-hen.*

OCHRA, a vegetable substance found in the West Indies, where it is used to thicken soup, as well as for other purposes.

OCHRE, (RED) REDDLE, or RED CHALK, is an iron ore of blood-red colour, which is sometimes found in powder, and sometimes in a hardened state. It has an earthy texture, and stains the fingers when handled. The principal use of red chalk is for drawing; the coarser kinds are employed by carpenters and other mechanics, and the finer kinds by painters. For the latter purpose it should be free from grit, and not too hard. In order to free it from imperfections, and render it better for use, it is sometimes pounded, washed, mixed with gum, and cast into moulds of convenient shape and size. Under the name of reddle this substance is much used for the marking of sheep; and, when mixed with oil, for the painting of pales, gates, and the wood work of outbuildings.

OCHROMA, a genus of plants belonging to the monadelphia class, and ranking in the natural method under the 35th class, columniferæ.

OCTAGON, in Geometry, is a figure of eight sides and angles, which, when the sides and angles are all equal, is called a regular octagon, and when they are not both equal, an irregular octagon. The angle at the centre of an octagon is 45 degrees, and the angle of its sides 135 degrees. The area of a regular octagon whose side is $1 = 2(1 + \sqrt{2}) = 4{\cdot}8284271$; and therefore when the side is $s$, the area $= 4{\cdot}8284271\,s^2$, and the radius of its circumscribing circle $= \frac{s}{\sqrt{(2 - \sqrt{2})}}$.



*On a given Line* A B *to construct a regular Octagon.*—On the extremities of the given line A B, erect the indefinite perpendiculars A F, B E, and produce A B both ways to *m* and *n*. Bisect the angles *m* A F, *n* B E, by the lines A H and B C, and take A H and B C both equal to A B. Draw G H and D C parallel to A F or B E, and each equal to A B; then from G and D as centres, with radius A B, describe arcs cutting the perpendiculars in F and E. Join F G, F E, and E D, so is A B C D E F G H, the octagon required.

OCTANDRIA, the eighth class of Linnæus's sexual system, consisting of plants having eight stamina.

OCTANS HADLIENUS, *Hadley's Quadrant*, is the Polar constellation in the southern hemisphere; it contains forty-three stars, of which one is of the third magnitude, and all the rest are under the fourth. The splendid nebula near the South Pole, and called by sailors the Magellanic cloud, appears to the naked eye like a part of the Milky Way, but through a telescope like a mixture of clouds and stars.

OCTANT, the eighth part of a circle.

OCTANT, or *Octile*, is also an ancient term in astronomy, to denote one of the aspects, *viz.* when two planets are distant from each other 45°.

OCTAVE, in Music, an harmonical interval, consisting of seven degrees or lesser intervals.

OCTAVE. *See* CHORD.

OCTOBER, being the eighth month of the ancient Roman calendar, but the tenth according to the Julian year. This month contains 31 days, on or about the 22d of which the sun enters the sign Scorpio.

The Kalendar of *Animated Nature* around London, presents in this month, the red-wing, at the same time that snakes and vipers bury themselves. Hooded-crows and wood-pigeons arise, hen-chaffinches congregate and prepare to remove to another climate, leaving their males here. The snipe appears in the meadow ditches, wild geese quit the fens for the rye lands, rooks visit their nest trees, some larks sing, the woodcock returns, and spiders' webs abound.

In *Vegetable Nature*, we find the arbutus, the holly, the China holly-hock, and the China aster in bloom. The leaves of many trees are now quite yellow, and others fall off profusely. Various annual plants are in flower.

In the *Kitchen Garden*, culinary vegetables, as the small salads, lettuces, radishes, are sown, as are Mazagan beans, and hotspur or frame pease. To save seed, cabbages, savoys, beet, parsnips, carrots, turnips, bulbing and Welsh onions, are transplanted; newly raised annuals must be protected, culinary perennials propagated; endive and lettuce transplanted to warm borders. The routine culture of earthing, hoeing, weeding, digging and trenching must not be neglected. Take up potatoes, beet, Jerusalem artichokes, parsnips, salsafy, scorzonera, skirret, and horse-radish of two years' growth, and preserve them in dry sand from the sea-shore. Gravel-pit sand is not by any means good for this purpose, as it very frequently holds the drift of vegetable substances, or earth.

In the *Hardy Fruit Department*, all sorts of hardy fruit trees are to be planted as soon as the leaves have dropped off; fig-trees are to be protected; late grapes shielded from frost by matting; except the raspberry, elder, and fig, all sorts of fruit trees are to be pruned; ground for new plantations is to be prepared; grapes, apples, and other fruits, must now be gathered; and long keepers are to be barrelled and stored in the fruit-room, or cellar.

In the *Culinary Hot-house Department*, in the glass-case without artificial heat, plant lettuces and cauliflowers under frames to stand the winter, sow small salads, slacken the heat in hot-beds and pits. In the pinery, shift and renew the bark-bed; prune in the forcing-house, cleanse and repair flues, mend broken glass, and paint when necessary.

In the *Flower Garden open Department*, sow annuals in pots for prolongation, in cold frames and pits; and some of the hardier sorts in warm borders, for the following early spring; as larkspur, adonis, belvedere, pansy, persicaria, annual stock. Propagate by dividing the root, as of daisies and of other edging plants. Plant border bulbs; transplant biennials and perennials, in the flower nursery, to stand till the spring. Protect auriculas, carnations, and other flowers, from heavy rains. Remove dahlia roots to dry in the open shed, preparatory to carrying them into the store-room. In the routine culture, prepare composts, stir the ground only in dry weather.

In the *Flower Garden Hot-house Department*, begin about the middle of the month to fill frames and pits with pots of mignonette, stocks, &c. for prolongation during the winter season; roses and hyacinths may now be put in bottom heat, and water-glasses brought into use. All plants must be replaced in the green-house, which should have air night and day when the temperature keeps up to 35°. Fires must be applied to the dry stove to keep the temperature at 47°; but in the bark or moist stove, the medium heat should be 70°.

In the *Pleasure Ground* and *Shrubbery*, plant hardy trees, prune evergreens, clear away all rubbish, roll, mow, sweep, hoe, weed. And in the *Nursery Department*, sow for stocks. The plum, cherry, almond, medlar, apple, pear, quince, barberry, service-tree, walnut, filbert, and hazel, may be sown. Cuttings of elder planted, fruit trees removed, as this is the best month for transplanting them. Permanent plantations and park scenery may now be planted, except in bleak situations, when the spring does best. Thin, prune, and fell generally; and let all drainings be worked now. In short, operations on grounds should now be executed vigorously, in all weathers; as it is better to keep the men on, than, with the view of saving a few pounds, lose a portion even of indifferent weather in October.

**ODE**, a song or a composition proper to be sung.

**ODD NUMBER**, that which cannot be divided into two equal integral parts, or which, when divided by 2, leaves a remainder 1.

**ODDLY ODD NUMBER**, that when divided by 4 leaves 3 for a remainder, or that which is of the form $4n + 3$.

**ODOMETER**, is an instrument for measuring the distance travelled over by a post chaise or other carriage; it is attached to the wheel, and shews, by means of an index and dial-plate, the distance gone over.

**ODOURS**, those invisible particles which disengage themselves from different bodies by the action of some gas, or by friction, mixture, and fermentation; and also by the exhalent vessels of animals and vegetables. They are also called effluvia, a learned term to conceal ignorance; for nobody can tell what these effluvia are. It is probable that these particles, if such there be, are kept in the state of gas, or vapour, by the presence of heat. All bodies, for any thing we know, may give out these particles, though we can perceive only such of them as affect our sense of smell.

What renders this probable, is, that many substances which are thought to be without smell in one circumstance, smell strongly in others. Flint and quartz, for instance, give out a strong smell on being rubbed or struck: clay smells on being wetted; arsenic, on being heated, smells like garlic; and gold and other inodorous metals, in some circumstances, smell strongly. The particles must be very minute, however much they may affect the organ, at least if we may judge of this by their weight. This can be shewn by an experiment; but it takes some time to perform it.

*Experiment on Odours.* Take a grain of musk, very accurately weighed in the most delicate balance. Put it in such a place as it may be kept from moisture or dust, while it has free access to the air. Allow it to remain here for one, two, three, or twelve months. During all this time it will not cease to diffuse a strong odour all around it. Weigh it again very nicely at the end of the period you have allotted for the experiment, and you will find that it has not lost the least perceptible weight, though it has been for so long giving out daily and hourly a strong odour. Yet if we believe Le Cat, who has given us no reason for his opinion, but puts us off with a simile—odours are much heavier than air, and rise in it only in consequence of the velocity with which they are ejected from bodies, as a horse at full speed, and the wind together, raise a cloud of heavy dust; although however, the foregoing experiment has been repeatedly urged as conclusive, we are disposed to doubt the legitimacy of the inference. For why may not odours be similar in their nature to heat, to light, to the magnetic, to the galvanic, or to the electric principles?

Odours cannot be perceived by any of the senses but smelling. We cannot see them, hear them, nor touch them, and we think it is somewhat doubtful whether we can taste them. Do they not then bear a close analogy to light and heat in this respect; though they be not susceptible of reflection and refraction as light and heat are, because odours are not propagated in straight lines? They differ from sound in being capable of transmission through a vacuum made by an air pump, a property which might be advantageously made use of for investigating their properties more accurately than has yet been done.

During the rage for discovering chemical elements, which prevailed some years ago, it was maintained that *aroma* was an element of this sort, on the same vague fancy that colouring matter and extractive, and miasma, were set down as such; and the opinion still lingers among those who trust to the authority of names and of books, rather than be at the trouble of thought or inquiry for themselves. Fourcroy proved the opinion false as it regarded aroma; and we believe it is equally so in other cases.

*How Smell is produced.*—However this may be, it is clear enough, that the odoriferous principles, particles, or gases, are drawn up into the nostril in breathing; and by mixing or combining with the fluid which covers the nerves, produce in these nerves the sensation of smell. The moistness of the membrane in indispensable to the sensation of smell, for when the membrane becomes dry, no smell is perceived. The moisture may act, perhaps, as a solvent for the odoriferous principle; or it may increase the sensibility of the nerves. Smell also is only produced on drawing in the breath: when the air is returning from the lungs, it does not produce the sensation, unless the lungs, or the parts about the mouth, be diseased. In those persons who have the nose flattened, who have very small nostrils, or have the nose otherwise deformed or destroyed by accident or disease, this sense is either wholly wanting or very imperfect. When it is destroyed by palsy, or otherwise lost, the sense of touch still remains in it, as may be proved by introducing irritating substances. Odours are conveyed in a similar way through water to the organs of smell in fishes, as may be proved by a simple

*Experiment.*—Put a piece of half putrid flesh or fish, which smells strongly, into a box full of holes sufficient to admit of the passage of a large eel. Place this in a pond or other piece of water where eels abound; and in a few hours, it will be filled with eels, drawn thither by the smell of the meat. It is supposed by the French chemists, that the moisture of the nostrils has a stronger affinity, or appetency, as Darwin would call it, for odours than it has for air, and consequently, that it seizes on the odours, separates them from the air, and allows the air to pass on after parting with them. This is pure supposition.

*Smell of Flowers in the Night.*—The air, as all must have remarked, is better fitted when it is cool and moist, for conveying odours, than when dry and warm, as many flowers give out perfumes at night, which are not perceived by day; the nodding thistle (called by botanists *carduus nutans*) for example, the musk mallow, the sweet-scented orchis, and more particularly the night smelling wallflower, (called by botanists *cheiranthus tristis.*) In the case of the last of these, however, the greater moistness of the air at night will not explain the phenomenon, as the flower begins to smell about six o'clock, and in a few hours after becomes quite scentless, and remains so till the succeeding evening. Odours cannot well be classed, for animal odours, such as musk, are found in vegetables, as in the musk geranium; and vegetable odours are found in metals, as the smell of garlic from heated arsenic. The blossom of the stapelia smells so like putrid flesh, that it deceives the flesh-fly so far as to make her deposit her eggs in it; and the same takes place with some species of mushroom.

*Effect of Odours on the Brain.*—The nerves of smell, perhaps from their great exposure, and from their vicinity to the brain, are very apt when excited to act powerfully on the brain, and through it on the whole nervous system. Volatile alkali or hartshorn, as is well known, will in this way recover a person from fainting, or even prevent it; and pleasant odours, such as that of a bean-field, or of a flower garden, will sometimes induce headache. The smell of ardent spirits, of wine, and other fermented liquors, will in some cases produce intoxication, as if they had been taken into the stomach; and the smell of some medicines, Haller says, will act on the bowels like aperients taken by the mouth. M. Majendie is, as usual, doubtful of this explanation of the facts. He thinks in the case of the odour arising from wine, supposed to produce intoxication, that it is the actual particles of the wine floating into the air which are swallowed into the stomach; and that the same holds of a man having his bowels opened by pounding a large quantity of jalap or gamboge. This, however, will not explain the instantaneous emetic effect of some nauseous smells; nor perhaps the effect of strongly odoriferous medicines in hysteric affections.

Odours also act on the stomach through the influence of the associated nerves. We are told that Dumourier lived three days on the smell of hot bread; and Lord Bacon mentions the case of a man who lived a considerable time on the smell of garlic. Any very nauseous smell also will, in weak or sickly people, produce retching and squeamishness. It is probable that odours have likewise some influence on the lungs, though this is less easy to ascertain with accuracy. Some very pungent odours, however, excite coughing, such as the odour, if we may call it so, arising from oxymuriatic gas, from strong camphor, and from turpentine.

*Use of Smell.*—The use of the sense of smelling has certainly been much over-rated by some writers, in the instance of its guiding us to a choice of food. It acts no doubt so far in conjunction with taste, in determining what is fit to be eaten. Smell particularly warns us to avoid eating what is putrid. But man is in this much inferior to the lower animals, and has to trust both to his former experience, and to the reports of the taste, the eye, and the hand. In many cases we are even deceived by smell as to what is fit for food; as several things are not unwholsome which are by no means agreeable to the smell. We may give as instances of this, salt fish, onions, garlic, mustard, old cheese, which are offensive to the smell of most people, though they are generally relished as food. Besides, we are fond of many smells which are produced by substances otherwise quite useless to us; such as the fragrance of lavender, thyme, ottar of roses;—in the same way as cats are fond of the smell of valerian and nepeta, though to them these are of no use whatever as food.

*Experiment.*—Take a piece of fresh valerian root, or the fresh stem of catmint (called by botanists *nepeta cataria*), and hold it out to a cat to smell. She will be as eager to seize it as if it were a mouse, though she will not eat it. By this means you may cause a cat to follow you to any distance you please. The experiment is not found to succeed with very young cats, either because they are deficient in smell while young, or because the influence of the odours depends on some sexual feeling.

Chemists long thought that the odoriferous part of bodies formed a peculiar principle, distinct from all the other substances entering into their composition, and which they called *aroma.* Most bodies allow excessively minute particles to be detached and diffused in the atmosphere, which becomes loaded therewith, and sometimes carries them to a considerable distance, as well as conveys them to the olfactory organs. These particles constitute odours; and the infinite variety of them from different substances exhaled, renders it extremely difficult to classify them; but in a work of this description their classification is wholly unnecessary.

Bodies whose particles are fixed, are termed *inodorous.* The odour of every body is peculiar to itself, yet there is a great difference among them, as to the mode in which the odours are detached; with some it is only when they are heated, with others only when rubbed; some give only a very faint, others a very strong smell. Such is the tenuity of odorous particles, that a body may, during a long time, disengage them without sensible diminution of weight.

The atmosphere becomes loaded with the greater quantity, the warmer and the more moist it is. We know that in a flower garden, the air is never loaded with fragrant odours, nor is the smell ever the source of pleasing enjoyment, so much as in the morning, when the dew is evaporating by the rays of the sun. By the smell we perceive the odorous effluvia taken in by inspiration, and principally applied to the Schneiderian membrane, causing very delicate and delightful impressions; and no sensations are remembered in so lively a manner as those of peculiar odours.

Wonderful, indeed, is the variety of odours in the vegetable kingdom, and the sweet perfume of flowers is no less remarkable than the brilliancy of their lovely hues. Indeed, there is as much variety in the odours of flowers as in the flowers themselves. The extreme subtlety of the particles which flowers exhale, is such, that the smell of the rosemary which grows in Provence reaches twenty miles beyond sea; and a grain of amber can fill a room twenty feet square, and fifteen feet high, with its perfume.

Odorous bodies may be regarded as fugitive and tenacious; for the most pungent usually evaporate most speedily, as ether, alcohol, the spirituous tinctures, and essential volatile oils. They are likewise —*musky*, as those of musk and the rose, characterized by their tenacity;—*aromatic*, as the smell of the laurel;—*fragrant*, as the lily, saffron, and the jasmine, whose smell is very fugitive;—*fetid*, as of valerian and fungi;—*virulent*, as of poppies and opium; *spermatic*, approaching that of garlic;—*pungent*, as of mustard;—*nauseous*, as of gourds, melons, cucumbers, and most cucurbitaceous plants;—*muriatic*, as that of saline substances: distinguishable further, as *weak*, *strong*, *agreeable*, and *disagreeable*. In most cases, however, an odour is described by comparing it to that of some well-known substance.

Odours are supposed to possess nutritive, medicinal, and even poisonous properties; but, in the cases which have caused these opinions, probably the influence of odours has been confounded with the effects of absorption. A man after pounding jalap for some time, will be purged as if he had swallowed it. These effects ought not to be ascribed to the odour, but to the particles diffused in the atmosphere, and introduced into the circulation, either with the saliva, or the air which he inspired: to the same cause must be attributed the intoxication of persons exposed for some time to the vapour of spirituous liquors.

Liquids, vapours, and gases, with many solids, reduced to an impalpable or even coarser powder, have the power like odours of affecting the organs of smelling. But the mechanism of their action is rather different;—the air is the ordinary vehicle of odours, and transports them to a distance, as well as to the pituitary membrane which lines the nasal canals, but which is only affected by odours, however, when inhaled by the nostrils. Hence, when any odour is agreeable or grateful, we employ short and frequent inspirations, that the whole of the air received into the lungs may pass through the nasal fossæ; and, on the contrary, we breathe through the mouth, or suspend respiration, for a time, when the odour is disagreeable.

Bodies reduced to a coarse powder, have also a strong action on the pituitary membrane; their first action is painful; but custom at length converts the pain into a pleasure, as we see in the example of tobacco. The odours in the upper part of the nasal cavities are more easily and strongly perceived; hence we modify inspiration so that the air may be directed towards this point, when we wish to smell a body strongly or accurately; hence also, snuff-takers endeavour to carry it towards the vault of the nostrils and olfactory nerves; the minute ramifications of which are distributed throughout the whole concavity of the former. Wonderful, indeed, is the care of nature in providing the nasal fossæ with a covering of hair to intercept the particles of odoriferous bodies from attacking the nerves too precipitately, and communicating impressions to the brain, till it is as it were previously prepared to be excited by them.

But, odours may be likewise propagated under an exhausted receiver; and certain bodies project odorous particles with some force. They may be attached to, or combined with, many liquids and solids, to fix or preserve them for any length of time.

OECUMENICAL, signifies the same with general, or universal, as oecumenical council, bishop, &c.

OEDEMA, in Surgery, a phlegmatic tumour, attended with paleness and cold, which obtains a place in any part of the body, but particularly the feet.

OENOTHERA, *Tree Primrose*, a genus of plants belonging to the octandria class, and in the natural method ranking under the 17th order Calycanchemæ.

OESOPHAGUS, the gula, or gullet, is a membranaceous canal, reaching from the fauces to the stomach, and conveying into it the food taken in at the mouth.

OESTRUS, GAD FLY, a genus of insects of the order diptera, extremely troublesome to horses, sheep, and cattle, depositing their eggs in different parts of the body, and producing very painful tumours, and sometimes death. The larvæ are without feet, short, thick, and annulate, and often furnished with small hooks. There are twelve species named, from the animals which they infest.

OFFENCE. Capital offences are those for which the offender loses his life; not capital where the offender, may lose his lands and goods, be fined, or suffer corporeal punishment, or both, but which are not subject to the loss of life.

OFFICE, that function, by virtue of which a person has some employment in the affairs of another. An office is a right to exercise any public or private employment, and to take the fees and emolument belonging to it, whether public, as those of magistrates; or private, as of bailiffs, receivers, &c. To offer money to procure the reversion of an office in the gift of the crown, is a misdemeanor at common law, and punishable by information; and even the attempt to induce, under the influence of a bribe, is criminal, though never carried into execution. An instance of which occurred under the administration of Mr. Addington, who prosecuted a tinman for offering him a sum of money for a place in the customs. Any contract to procure the nomination to an office, not within the statute of 6 Edward VI. is defective on the ground of public policy; and the money agreed to be given is not recoverable.

OFFICER. The great officers of the crown, or state, are the Lord High Steward, the Lord High Chancellor, the Lord High Treasurer, the Lord High President of the Council, the Lord Privy Seal, the Lord Chamberlain, the Lord High Constable, the Earl Marshal.

OFFICERS, *Field*, are such as command a whole regiment, as the colonel, lieutenant-colonel, and major.

OFFICERS, *General*, are those whose command extends to a body of forces, composed of several regiments: such are generals, lieutenant-generals, major-generals, and brigadiers.

OFFICERS, *Staff*, are such as, in the king's presence, bear a white staff, or wand; and at other times, on their going abroad, have it carried before them by a footman, bare-headed; such are the Lord Steward, Lord Chamberlain, Lord Treasurer, &c.

OFFICERS, *Commission*, are those appointed by the king's commission: such are all from the general to the cornet inclusive, who are thus denominated in contradistinction to warrant officers, who are appointed by the colonel's or captain's warrant, as quarter-masters, sergeants, corporals, and even chaplains and surgeons.

OFFICERS, *Subaltern*, are all who administer justice in the name of subjects; as those who act under the Earl Marshal, Admiral, &c. In the army the subaltern officers are the lieutenants, cornets, ensigns, sergeants, and corporals.

OFFICIAL, by the ancient law, signifies him who is the minister of, or attendant upon, a magistrate. In the cannon law, it is especially taken for him to whom any bishop generally commits the charge of his spiritual jurisdiction; and in this sense there is one in every diocese called *officialis principialis*, whom the laws and statutes of this kingdom call chancellor. 32 Hen. VIII. 15.

OFFICINA SCULPTORIS, the *Sculptor's Shop*, is a small constellation, composed by M. La Caille on the south of Cetus, and containing, acording to Flamstead, twelve stars, spread over a considerable space of the firmament, but none of them exceeding the fifth magnitude.

OFFING, or OFFIN, that part of the sea a good distance from shore, where there is deep water, and no need of a pilot to conduct the ship.

OFFSETS, in Gardening, those young shoots that spring from the roots of trees or plants, which being carefully separated and planted in a proper soil, serve to propagate the species.

OFFSETS, in Surveying, are those short perpendiculars that are measured on the sides of irregular figures, for the more accurate determination of the area.

OFFSET *Staff*, a staff or rod used in surveying for measuring effects. It is commonly made of light wood ten links in length, divided and numbered from one end to the other.

OFFWARD, the situation of a ship which lies aground, and leans from the shore: thus they say, "the ship heels offward," when being aground she heels towards the water side; and "the ship lies with her stern to the offward, and the head to the shoreward," when her stern is towards the sea and head to the shore.

OGEE, in Architecture, or O, G, a moulding consisting of two members; one concave and the other convex, or of a round and hollow like an S.

OGIVE, in Architecture, an arch or branch of a gothic vault, which, instead of being circular, passes diagonally from one angle to another, and forms a cross with the other arches. The middle, when the ogives cross each other, is called the key, being cut in a rose or *cul de lamp*. The members or mouldings of the ogives are called *nerves, branches, veins*; and the arches which separate the ogives, *double arches*.

OIL, an unctuous inflammable substance, extracted from several natural bodies, whether animal or vegetable, as whale oil, olive oil, &c.

*Oil obtained from Rape Seed by Pressure.*—This is used in large quantities by clothiers and others, and likewise in medicine, and frequently for making the soap called green soap. It is also useful for various purposes in domestic life, and particularly for burning in lamps; but it is apt to become rancid, though there are means of purifying it. After the oil has been extracted, the refuse is called *oil-cake*, and is employed for the fattening of oxen, and in Norfolk is sometimes broken to pieces and strewed on the land as manure. The roots of rape plants may be eaten like turnips, but they have a stronger taste. The stalks of haulm, if strong, may be advantageously employed for the enclosing fences of farm yards. They are, however, generally burnt, and in some parts of the country the ashes, which are equal to the best pot-ashes, are collected together and sold.

*To Prepare an Oil for Clocks and other delicate Machinery.*—The oil for diminishing friction in delicate machines, ought to be completely deprived of every kind of acid and mucilage: and to be capable of enduring a very intense degree of cold without freezing. In fact, it ought to consist entirely of elaine or the oily principle of solid fat, and to be perfectly free from stearine or solid fat. Now it is not a difficult matter to extract the elaine from all the fixed oils, and even from seeds, by the process recommended by Chevreul, which consists in treating the oil in a mattrass with seven or eight times its weight of alcohol till boiling. The liquid is then to be decanted, and exposed to the cold, the stearine will then separate from it in the form of a crystallized precipitate. The alcoholic solution is afterwards to be evaporated to a fifth part of its volume, and the elaine will then be obtained, which ought to be colourless, insipid, without smell, and incapable of altering the colour of the infusion of litmus or turnsole, and having the consistence of pure white olive oil.

**OIL MILL.** This machine is used for expressing their oils from fruits, grains, &c.; and the following description, which is given in Dr. Gregory's Mechanics, is that of a Dutch mill employed for grinding and expressing lint and rape seed, &c. The original mill is put in motion, we believe, by *wind;* the Doctor, however, employs water as a first mover.

In the Plate Oil Mill, &c. fig. A, 1 is the elevation of a wheel, over or under shot, as the situation may require. 2, the bell-metal socket, supported by masonry, for receiving the outer gudgeon of the water wheel. 3, the water course.

Fig. B. 1, a spur wheel upon the same axis, having 52 teeth. 2, the trundle that is driven by No. 1, and has 78 staves. 3, The wallower, or axis for raising the pestles. It is furnished round its circumference with wipers for lifting the pestles, so that each may fall twice during one turn of the water wheel, that is, three wipers for each pestle. 4, a frame of timber, carrying a concave half-cylinder of bell metal, in which the wallower (cased in that part with iron plates) rests and turns round. 5, masonry supporting the inner gudgeon of the water wheel, and the abovementioned frame. 6, gudgeon of the wallower, which bears against a bell-metal step fixed in the wall. This double support of the wallower is found to be necessary in all mills which drive a number of heavy stampers.

Fig. C is the elevation of the pestle and press frame, their furnitures, the mortars, and the press pestles. 1, the six pestles. 2, cross pieces between the two rails of the frame, forming, with these rails, guides for the perpendicular motion of the pestles. 3, the two rails. The back one is not seen. They are checked and bolted into the standards No. 12. 4, the tails of the lifts, corresponding to the wipers upon the wallower. See the article Wiper. 5, another rail in front, for carrying the detents which hold up the pestles when not acting. It is marked 14 in fig. M. 6, a beam a little way behind the pestles. To this are fixed the pulleys for the ropes which lift and stop the pestles. It is represented by 16 in fig. M. 7, the said pulleys with their ropes. 8, the driver, which strikes the wedge that presses the oil. 9, the discharger, a stamper which strikes upon the inverted wedge, and loosens the press. 10, the lower rail with its cross pieces, forming the lower guides of the pestles. 11, a small cog wheel upon the wallower, for turning the spatula, which stirs about the oil seed in the chauffer pan. It has 28 teeth, and is marked No. 6 in fig. M. 12, the four standards, mortised below into the block, and above into the joists and beams of the building. 13, the six mortars hollowed out of the block itself, and in shape pretty much like a kitchen pot. 14, the feet of the pestles, rounded into cylinders, and shod with a great lump of iron. 15, a board behind the pestles, standing on its edge, but inclining a little backwards. There is such another in front, but not represented here. These form a sort of trough, which prevents the seed from being scattered about by the fall of the pestles, and lost. 16, the first press box, (also hollowed out of the block,) in which the grain is squeezed, after it has come for the first time from below the millstones. 17, the second press box, at the other end of the block, for squeezing the grain after it has passed a second time under the pestles. 18, frame of timber for supporting the other end of the wallower, in the same manner as at No. 4, fig. B. 19, small cog wheel on the end of the wallower, for giving motion to the millstones. It has 28 teeth. 20, gudgeon of the wallower, bearing on a bell-metal socket fixed in the wall. 21, vessels for receiving the oil from the press boxes.

Fig. D. Elevation and mechanism of the millstones. 1, upright shaft, carrying the great cog wheel above, and the runner millstones below in their frame. 2, cog wheel of 76 cogs, driven by No. 19, of fig. C. 3, the frame of the runners. 4, the innermost runner, or the one nearest the shaft. 5, outermost ditto, being further from the shaft. 6, the inner rake, which collects the grain under the outer runner. 7, the outer rake, which collects the grain under the inner runner. In this manner the grain is always turned over and over, and crushed in every direction. The inner rake lays the grain in a slope, of which fig. O is a section; the runner flattens it, and the second rake lifts it again, as is marked in fig. P; so that every side of a grain is presented to the millstone, and the rest of the legger or nether millstone is so swept by them, that not a single grain is left on any part of it. The outer rake is also furnished with a rag of cloth, which rubs against the border or hoop that surrounds the nether millstone, so as to drag out the few grains which might otherwise remain in the corner. 8, the ends of the iron axle which passes through the upright shaft, and through the two runners. Thus they have two motions: 1mo, a rotation round their own axis; 2do, that by which they are carried round upon the nether millstone on which they roll. The holes in these millstones are made a little wide; and the holes in the ears of the frame, which carry the ends of the iron axis, are made oval up and down. This great freedom of motion is necessary for the runner millstones, because frequently more or less of the grain is below them at a time, and they must therefore be at liberty to get over it without straining, and perhaps breaking, the shaft. 9, the ears of the frame which lead the two extremities of the iron axis. They are mortised into the under side of the bars of the square frame, that is carried round with the shaft. 10. The border or hoop which surrounds the nether millstone. 11 and 12, the nether millstone, and masonry which supports it.

Fig. K. Plan of the runner millstones, and the frame which carries them round. 1, 1, are the two millstones. 3, 3, 3, 3, the outside pieces of the frame. 4, 4, 4, 4, the cross bars of the frame which embrace the upright shaft 5, and give motion to the whole. 6, 6, the iron axis upon which the runners turn. 7, the outer rake. 8, the inner ditto.

Fig. L represents the nether millstone seen from above. 1, the wooden gutter, which surrounds the nether millstone. 2, The border or hoop, about six inches high all round, to prevent any seed from being scattered. 3, an opening or trap door in the gutter, which can be opened or shut at pleasure. When open, it allows the bruised grain collected in and shoved along the gutter by the rakes to pass through into troughs placed below to receive it. 4, portion of the circle described by the outer runner. 5, portion of the circle described by the inner one. By these we see that the two stones have different routes round the axis, and bruise more seed. 6, the outer rake. 7, the inner ditto. 8, the sweep, making part of the inner rake, occasionally let down for sweeping off all the seed when it has been sufficiently bruised. The pressure and action of these rakes is adjusted by means of wooden springs, which cannot be easily and distinctly represented by any figure. The oblique position of the rakes (the outer point going foremost) causes them to shove the grain inwards or toward the centre, and at the same time to turn it over, somewhat in the same manner as the mould board of a plough shoves the earth to the right hand, and partly turns it over. Some mills have but one sweeper, and, indeed, there is great variety in the form and construction of this part of the machinery.

Fig. M, profile of the pestle frame. 1, section of the horizontal shaft. 2, three wipers for lifting the pestles. *See* Wiper. 3, little wheel of 28 teeth, for giving motion to the spatula. 4, another wheel, which is driven by it, having 20 teeth. 5, horizontal axle of ditto. 6, another wheel on the same axle, having 13 teeth. 7, a wheel upon the upper end of the spindle, having 12 teeth. 8, two guides, in which the spindle turns freely, and so that it can be shifted higher and lower. 9, a lever, moveable round the piece No. 14, and having a hole in it at 9, through which the spindle passes, turning freely. The spindle has in this place a shoulder, which rests on the border of the hole 9; so that by the motion of this lever the spindle may be disengaged from the wheel work at pleasure. This motion is given to it by means of the lever 10, 10, moveable round its middle. The workman employed at the chauffer pulls at the rope 10, 11, and thus disengages the spindle and spatula. 11, a pestle seen sidewise. 12, the lift of ditto. 13, the upper rails, marked No. 3 in fig. C. 14, the rail, marked No. 5 in fig. C. To this are fixed the detents, which serve to stop and hold up the pestles. 15, a detent, which is moved by the rope at its outer end. 16, a bracket behind the pestles, having a pulley, through which passes the rope going to the detent 15. 17, the said pulley. 18, the rope at the workman's hand, passing through the pulley 17, and fixed to the end of the detent 15. This detent naturally hangs perpendicular by its own weight. When the workman wants to stop a pestle, he pulls at the rope 18, during the rise of the pestle. When

# Oil Mill, Calamine, Boring

Fig. A

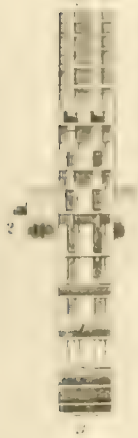


Fig. B

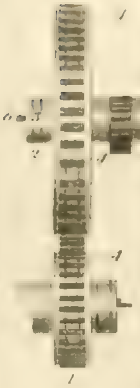


Fig. C

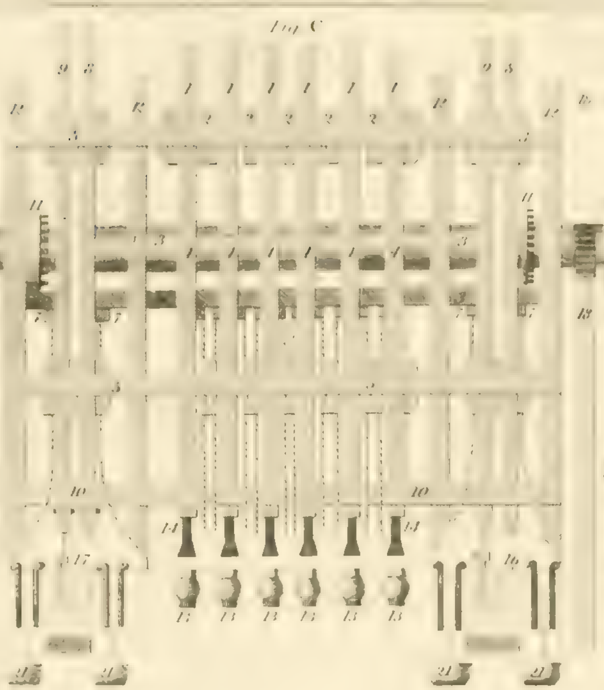
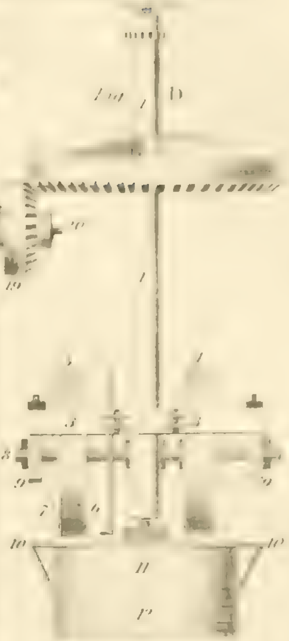


Fig. D



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 36

Fig. M.

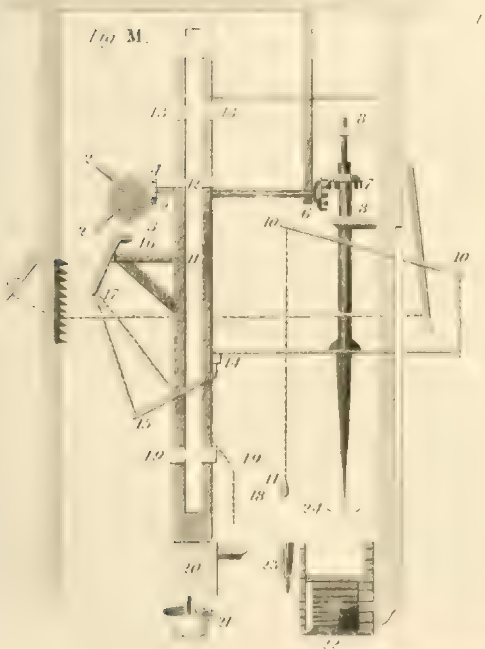
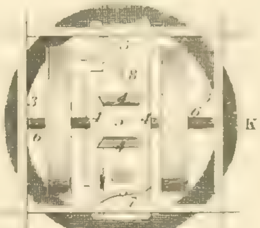
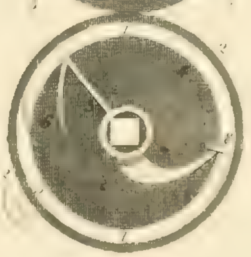
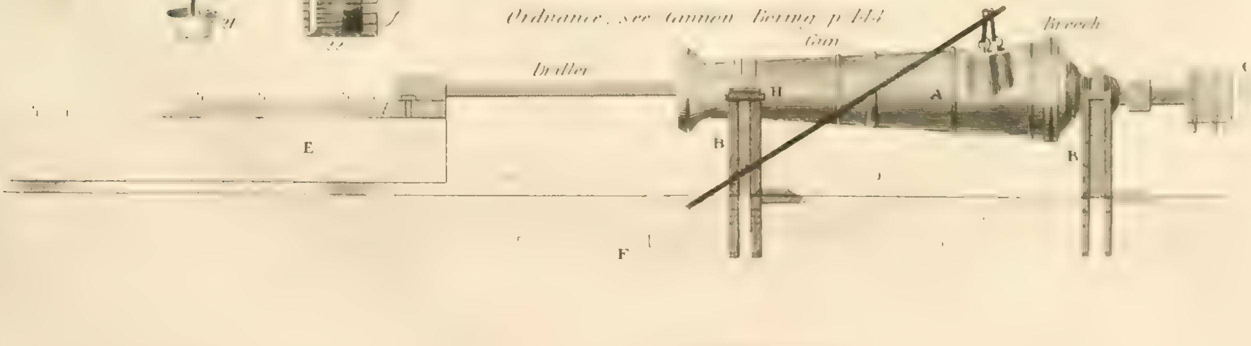


Fig. O Fig. P





Ordnance, see Cannon Boring p 144



this is at its greatest height, the detent is horizontal, and prevents the pestle from falling by means of a pin projecting from the side of the pestle, which rests upon the detent, the detent itself being held in that position by hitching the loop of the rope upon a pin at the workman's hand. 19, the two lower rails, marked No. 10, fig. C. 20, Great wooden, and sometimes stone, block, in which the mortars are formed, marked No. 21 in fig. C. 21, vessel placed below the press boxes for receiving the oil. 22, Chauffer, or little furnace, for warming the bruised grain. 23, backet in the front of the chauffer, tapering downwards, and opening below in a narrow slit. The hair bags, in which the grain is to be pressed after it has been warmed in the chauffer, are filled by placing them in this backet. The grain is lifted out of the chauffer with a ladle, and put into these bags; and a good quantity of oil runs from it through the slit at the bottom into a vessel set to receive it. 24, the spatula attached to the lower end of the spindle, and turning round among the grain in the chauffer-pan, thus preventing it from sticking to the bottom or sides, and getting too much heat.

The first part of the process at an oil-mill is bruising the seed under the runner stones.* That this may be more expeditiously done, one of the runners is set about two-thirds of its own thickness nearer the shaft than the other. Thus they have different treads; and the grain, which is a little heaped towards the centre, is thus bruised by both. The inner rake gathers it up under the outer stone into a ridge, of which the section is represented in fig. O. The stone passes over it, and flattens it. It is gathered up again into a ridge, of the form of fig. P, under the inner stone, by the outer rake, which consists of two parts. The outer part presses close on the wooden border which surrounds the nether stone, and shoves the seed obliquely inwards, while the inner part of this rake gathers up what had spread toward the centre. The other rake has a joint near the middle of its length, by which the outer half of it can be raised from the nether stone, while the inner half continues pressing on it, and thus scrapes off the moist paste. When the seed is sufficiently bruised, the miller lets down the outer end of the rake. This immediately gathers the whole paste, and shoves it obliquely outwards to the wooden rim, where it is at last brought to a part that is left unboarded, and it falls through into troughs placed to receive it. These troughs have holes in the bottom, through which the oil drips all the time of the operation. This part of the oil is directed into a particular cistern, being considered as the purest of the whole; having been obtained, without pressure, by the mere breaking of the hull of the seed.

In some mills this operation is expedited, and a much greater quantity of this best oil is obtained, by having the bed of masonry which supports the legger formed in a little furnace, and gently heated. But the utmost care is necessary to prevent the heat from becoming considerable. This, enabling the oil to dissolve more of the fermentable substance of the seed, exposes the oil to the risk of growing soon very rancid; and, in general, it is thought a hazardous practice, and the oil does not bring so high a price.

When the paste comes from under the stones, it is put into the hair bags, and subjected to the first pressing. The oil thus obtained is also esteemed as of the first quality, scarcely inferior to the former, and is kept apart; (the great oil cistern being divided into several portions by partitions.) The oil cakes of this pressing are taken out of the bags, broken to pieces, and put into the mortars for the first stamping. Here the paste is again broken down, and the parenchyma of the seed reduced to a fine meal. Thus free egress is allowed to the oil from every vesicle in which it is contained; but it is now rendered much more clammy, by the forcible mixture of the mucilage, and even of the finer parts of the meal. When sufficiently pounded, the workman stops the pestle of a mortar when at the top of its lift, and carries the contents of the mortar to the first chauffer pan, where it is heated to about the temperature of melting bees' wax, (this, we are told, is the test,) and all the while stirred about by the spatula. From thence it is again put into hair bags, in the manner already described; and the oil which drips from it during this operation is considered as the best of the second quality, and in some mills is kept apart. The paste is now subjected to the second pressing, and the oil is that of the second quality. All this operation of pounding and heating is performed by one workman, who has constant employment by taking the four mortars in succession. The putting into the bags, and conducting of the presses, gives equal employment to another workman.

In the mills of Picardy, Alsace, and most of Flanders, the operation ends here; and the produce from the chauffer is increased, by putting a spoonful or two of water into the pan among the paste. But the Dutch take more pains. They add no water to the paste of this their first stamping. They say that this greatly lowers the quality of the oil. The cakes which result from this pressing, and are there sold as food for cattle, are still fat and softish. The Dutch break them down, and subject them to the pestles for the second stamping. These reduce them to an impalpable paste, stiff like clay. It is lifted out, and put into the second chauffer pan; a few spoonfuls of water are added, and the whole kept for some time as hot as boiling water, and carefully stirred all the while. From thence it is lifted into the hair bags of the last press, subjected to the press; and a quantity of oil of the lowest quality is obtained, sufficient for giving a satisfactory profit to the miller. The cake is now perfectly dry and hard, like a piece of board, and is sold to the farmers. Nay, there are small mills in Holland which have no other employment than extracting oil from the cakes which they purchase from the French and Brabanters; a clear indication of the superiority of the Dutch practice.

The nicety with which that industrious people conduct all their business is remarkable in this manufacture. In their oil cistern, the parenchymous part, which unavoidably gets through, in some degree, in every operation, gradually subsides; and the liquor, in any division of the cistern, comes to consist of strata of different degrees of purity. The pumps, which lift it out of each division, are in pairs; one takes it up from the very bottom, and the other only from half depth. The last only is barreled up for the market, and the other goes into a deep and narrow cistern, where the dreg again subsides, and more pure oil of that quality is obtained. By such careful and judicious practices, the Dutch not only supply themselves with this important article, but annually send considerable quantities even into those provinces of France and Flanders, where they bought the seed from which it was extracted. When we reflect on the high price of labour in Holland, on the want of timber for machinery, on the expense of building in that country, and in the enormous expense of windmill machinery, both in the first direction and the subsequent wear and tear, it must be evident, that oil mills erected in England on water falls, and after the Dutch manner, cannot fail of being a great national advantage. The chatellanie or seigneurie of Lille, alone makes annually between 30,000 and 40,000 barrels, each containing about 26 gallons.

What is here delivered is only a sketch. Every person acquainted with machinery will understand the general movements and operations. But the intelligent mechanic well knows, that operations of this kind have many minute circumstances which cannot be described, and which, nevertheless, may have great influence on the whole.—*Dr. Gregory's Machines*, vol. 2.

**OIL GAS.** If oil, tallow, or wax, be let fall upon red-hot iron, or made to pass through red-hot iron pipes, it will be resolved into a combustible gas. The fact was long known to chemists; and after the success of lighting by coal-gas was made apparent. Messrs. Taylor and Martineau contrived an ingenious apparatus for producing oil gas on a large scale, as a substitute for candles, lamps, and coal gas. Oil gas has several advantages over coal gas. It has no unpleasant smell in a room; it does not require the expense of being purified by lime: it will not injure in the least, books, pictures, or fine furniture; it has no corrosive effects on the pipes which convey it. It is far more economical than argand lamps, or mould or wax candles. It gives a very bright light; and one cubic foot of oil gas will yield much more light than the same quantity of coal gas. This last is a great advantage, where saving of room is important.

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* We are told, that in a mill at Reichenhoffen, in Alsace, a considerable improvement has been made by passing the seed between two small iron rollers, before it is put under the millstones. A great deal of work is said to be saved by this preliminary operation, and finer oil produced; which we think very probable. The stamping and pressing go on as in other mills.

OLBERS, a name sometimes given to the planet Pallas, discovered by Dr. Olbers, March 28th, 1802; but since the discovery of a second planet by the same astronomer, *viz.* Vesta, March 29th, 1807, the name Olbers is usually changed for that of Pallas, to prevent confusion between the two. *See* PALLAS.

OLEA, OLIVE, a genus of the diandria monogynia class and order. Natural order of sepiariæ. Jasmineæ, Jussieu. Essential character: corolla four-cleft; with subovate segments; drupe one-seeded. There are seven species. The olive seldom becomes a large tree; two or three stems frequently rise from the same root, from twenty to thirty feet in height, putting out branches almost their whole length, covered with a grayish bark. *See* OLIVE below.

OLEFIANT GAS. This gas differs from the common gas in this, that it consists of one prime of carbon and one of hydrogen, instead of one prime of carbon and two of hydrogen.

OLEIC ACID, is an oil obtained from potass and hogs' lard saponified, which has the property of saturating bases, and forming neutral compounds.

OLERON LAWS, laws relating to maritine affairs, and so called, because made when king Richard I. was at the Isle of Oleron, in Aquitaine.

OLFACTORY NERVES, the first pair of the head, so called from their being the immediate instruments of smelling.

OLIBANUM. A gum resin, the product of the Juniperus Lycia, brought from Turkey and the East Indies usually in drops or tears. The best is of a yellowish white colour, solid, hard, and brittle: when chewed for a little time, it renders the spittle white, and impresses an unpleasant bitterish taste; laid on burning coals, it yields an agreeable smell.

OLIGARCHY, a form of government wherein the admistration of affairs is lodged in the hands of a few persons.

OLIVE. The olive in all ages has been held in peculiar estimation, as the bounteous gift of Heaven; it is still considered as emblematic of peace and plenty; the great quantity of oil which it produces in some countries, effectually realizes the latter of these blessings. Unripe olives pickled, especially the Provence and Lucca sorts, are to many persons extremely grateful; they are supposed to promote digestion.

OLIVINE, in Mineralogy, a species of the chrysolite family, found in the form of crystals, chiefly in basalt; colour between asparagus and olive green; specific gravity 3·2.

OLLARIS LAPIS, or POTSTONE, found abundantly near the lake of Como, is made into pots, and is also employed in Greenland. Its constituents are silica 39, magnesia 16, oxide of iron 10, carbonic acid 20, water 10. It occurs in beds of primitive slate.

OLYMPIAD, in Chronology, a period of four years, by which the Greeks reckoned their time; being thus called from the Olympic games held every fourth year, during five days near the summer solstice, on the banks of the river Alpheus, near Olympia, a city of Elis. The first Olympiad began the year 3938 of the Julian period, corresponding to 776 years before Christ. The computation by these games ended with the 404th, being the 440th of the present Christian era.

OMBROMETER, a name given by Mr. Pickering to the pluviometer, or rain gauge.

OMNIUM, a term in familiar use among stock-brokers and speculators in the funds, to express the whole of the articles which the subscribers to a loan receive from government. Thus, if the subscribers, according to their agreement with government, are to have for every hundred pounds advanced a certain sum in 3 per cent. consols, a further sum in 4 per cents, and a proportion of the long annuities, the blank receipts which they receive for making the instalments on the several articles, are, when disposed of, independent of each other, as the 3 per cent. consols only, called scrip; when the receipts are sold together as originally received, they are usually called omnium. As the omnium of every loan is the subject of extensive speculations, it generally is liable to considerable variations with respect to its current price, sometimes selling at a high premium, at other times at a discount, according to the circumstances which take place between the agreement for the loan and the day fixed for paying the last instalment.

OMPHACITE, a mineral of a leek green colour, found in Carinthia.

OMPHALOPTER, a name sometimes given to a convex lens.

ONION, *The Common,* known by its cylindrical hollow leaves, and swelling pipy stalk, is a bulb that does not throw out offsets. Onions are propagated by seeds which are sown in spring; and the bulbs or roots arrive at perfection in the autumn. The whole plant when young is eaten as salad. Onions generally cease to grow towards the middle of August, the stalks and leaves at that time shrinking and turning brown. Shortly after this they must be drawn out of the earth; the tops and blades must be cut off; and the roots dried, either in a warm place, or by exposure to the sun. Spanish onions are of large size, and flattened shape; and Portugal onions are large, handsome bulbs, of roundish form. The kinds of onions in cultivation are, the Deptford, the Reading, the white Spanish, the Portugal, the Globe, and the Silver-skinned. All these varieties are usually sown in the spring of the year, and are good either eaten in their young state, or after they are dried in the winter. The silver-skinned kind is mostly in use for pickling. The globe and Deptford kinds are remarkable for keeping late in the spring. A portion of all the other sorts should be sown, as they are all very good, and some kinds will keep when others will not. By the common people, onions are frequently eaten raw with their food. This has particularly been the case, and from time immemorial, with the inhabitants of Egypt. By stimulating the stomach they are supposed to favour digestion; and some persons have imagined that they possess a large portion of alimentary matter: while others say that they afford little or no nourishment, and that, when eaten freely, they produce flatulencies, occasion thirst, headaches, and turbulent dreams. They have so much acrimony as generally to affect the breath for many hours; but when boiled or roasted this is in great measure dissipated, and they then exhibit some sweetness, with a considerable portion of mucilaginous matter. Onions are of great use in several culinary preparations, but particularly in soup and pickles. They are employed in medicine chiefly as poultices for swellings; and have been recommended, by some persons, to be rubbed on bald parts of the head, to promote the growth of the hair.

ONOCLEA, a genus of plants belonging to the cryptogamia class and order of Filices.

ONONIS, a genus of plants belonging to the diadelphia class.

ONOPERDUM, a genus of plants belonging to the syngenesia class, and in the natural method ranking under the 49th order, Compositæ.

ONOSMA, a genus of plants belonging to the pentandria class, and in the natural method ranking under the 41st order, Asperifoliæ.

ONYX. A chalcedony with alternate layers of white, black, and dark brown.

OPACITY, that quality of bodies which renders them opaque, in contradistinction to transparency.

OPAKE, or OPAQUE, not translucent nor transparent; or, that which prevents the free admission of the rays of light.

OPAL, in Mineralogy, a species of the quartz family, found in many parts of Europe, especially in Hungary. When first dug out of the earth it is soft, but it hardens and diminishes in bulk by exposure to the air. The specific gravity varies from 1·9. to 2·5. There are four sub-species, *viz.* the precious, the common, the semi, and the wood opal.

OPERA, a dramatic composition set to music, and sung on the stage, accompanied with musical instruments, and enriched with magnificent dresses, machines, and other decorations.

OPERA *Glass,* in Optics, so called from its use in theatres, &c. it is sometimes called a "diagonal perspective," from its construction. It consists of a tube about four inches long, in each side of which there is a hole exactly against the middle of a plane mirror, which reflects the rays falling upon it to the convex glass, through which they are refracted to the concave eyeglass, whence they emerge parallel to the eye at the hole in the tube. This instrument is not intended to magnify objects more than about two or three times. The peculiar artifice is to view a person at a small distance, so that no one shall know who is observed; for the instrument points to a different object from that which is viewed; and as there is a hole on each side, it is impossible to know on which hand the object is situated which you are looking at.

**OPHTHALMIA**, in Medicine, an inflammation of the membranes which invest the eye.

**OPHIDIUM**, a genus of fishes in the order Apodes.

**OPHIOGLOSSUM**, *Adder's Tongue*, a genus of plants belonging to the cryptogamia class, and to the order Filices.

**OPHIORHIZA**, a genus of plants belonging to the pentandria class, and in the natural method ranking under the 47th order, Stellatæ.

**OPHIOXYLON**, a genus of plants belonging to the polygamia class, and in the natural method ranking with those of which the order is doubtful.

**OPHIRA**, a genus of plants in the octandria class.

**OPHIUCHUS**, or SERPENTARIUS, and SERPENS, one of the old constellations, and which was anciently called Æsculapius. Its title of Serpentarius is due to the skill of Apollo's son in having restored Hippolytus to life, the Serpent entwined around Ophiuchus being the symbol of medicine, and of the gods who presided over this art; but the reptile may also be the symbol of prudence and vigilance.

*The Boundaries and Contents.*—This constellation, occupying a large portion of the heavens south of Hercules, is usually divided into two parts, one being assigned to Ophiuchus, and the other to Serpens. On the east it is bounded by Taurus Poniatowski and Scutum, south by Scorpio, and west by Böotes. The head of the Serpent is easily distinguished by some stars of the third and fourth magnitudes, which are found directly midway under Corona Borealis. They form, with $\gamma$ and $\beta$ of Hercules, the figure of a Y, the tail of which goes towards the south. Another of these, known as $\alpha$, of the second magnitude, shines very brightly, and forms the heart of the Serpent. The other stars become mixed with those in Ophiuchus. There are 134 stars in this constellation, of which two are of the second, fourteen of the third, thirteen of the fourth magnitude, &c. The most brilliant among them is $\alpha$ *Ras Alhague*, having 261° 38′ 32″ right ascension, and 12° 42′ 6″ of north declination. This star appears E.N.E. ¼ E. point of the compass, at London, and it rises and culminates as follows: Meridian Altitude, 51° 11′ 6″ N.

| MONTH. | RISES. | CULM. | MONTH. | RISES. | CULM. |
|---|---|---|---|---|---|
| | ho. mi. | ho. mi. | | ho. mi. | ho. mi. |
| Jan. | 3 35 M. | 10 44 M. | July | 3 45 A. | 10 44 A. |
| Feb. | 1 16 M. | 8 20 M. | Aug. | 1 45 A. | 8 45 A. |
| Mar. | 11 35 A. | 6 34 M. | Sept. | 11 46 M. | 6 46 A. |
| April | 9 40 A. | 4 35 A. | Oct. | 9 45 M. | 5 0 A. |
| May | 7 55 A. | 2 50 A. | Nov. | 7 50 M. | 3 5 A. |
| June | 5 45 M. | 12 45 M. | Dec. | 5 45 M. | 12 55 M. |

**OPHRYS**, *Twyblade*, a genus of plants belonging to the gynandria class, and in the natural method ranking under the 7th order, Orchideæ.

**OPHRYS APIFERA**, that is to say, *Bee Ophrys*, ranks among the few plants that are more generally admired than all the Orchideæ for their singular beauty and uncommon structure. The one in question so very much resembles the humble-bee in appearance, that I have known persons mistake this flower for the animal. It is unfortunate for the amateurs of gardening, that most plants of this tribe are difficult of propagation, and are not of easy culture. Botanists sometimes succeed with this and other species by the following method:—To take up the roots from their native places of growth as early as they can be found, and then to procure some chalk and sift it through a fine sieve, and also some good tenacious loam; mix both in equal quantities in water; a large garden-pot should then be filled with some rubble of chalk, about one-third deep, and then the above compost over it, placing the roots in the centre, at the usual depth they grew before. As the water drains away, the loam and chalk will become fixed closely round the bulbs, and they will remain alive and grow. By this method I have cultivated these plants for some years together. In this way all those kinds growing in chalk may be made to grow; but such as the Orchis *morio*, *maculata*, and *pyramidalis*, may be grown in loam alone, planted in pots in the common way. Care should be taken that the pots in which they are planted are protected from wet and frost in the winter season.

**OPIUM**, obtained from poppy seeds, is procured from Turkey, and is also now produced to a large amount in India, and is exported to China. It is a powerful narcotic.

**OPIUM**, in Chemistry and Medicine, an inspissated gummy juice, which is obtained from the head of the "papavera somniferum." It is imported from Persia, Arabia, and other warm parts of Asia, in flat cakes covered with leaves to prevent their sticking together. It has a reddish brown colour, and strong peculiar smell; its taste at first is nauseous and bitter, but this soon becomes acrid, and produces a slight warmth in the mouth.

**OPOBALSUM**. The most precious of the balsams is that commonly called Balm of Gilead, Opobalsamum, Balsamæleon, Balsamum verum album, Ægyptiacum, Judaicum, Syriacum e Mecca, &c. This is the produce of the amyris opobalsamum, L. The true balsam is of a pale yellowish colour, clear and transparent, about the consistence of Venice turpentine, of a strong, penetrating, agreeable, aromatic smell, and a slightly bitterish pungent taste.

**OPODELDOC**. A solution of soap and alcohol, with the addition of camphor and volatile oils. It is used externally against rheumatic pains, sprains, bruises, and other like complaints.

**OPOPONAX**. A concrete gummy resinous juice, obtained from the roots of an umbelliferous plant, the pastinaca opoponax, which grows spontaneously in the warmer countries, and bears the cold of this.

**OPPILATION**, in Medicine, the act of obstructing or stopping up the ducts or passages of the body by redundant or peccant humours.

**OPPOSITION**, in Astronomy, is that aspect of any two heavenly bodies, when they are diametrically opposite each other, or 180°, that is, a semicircle, apart.

**OPTICS**, the science of vision, including Catoptrics and Dioptrics, and even Perspective; as also the whole doctrine of light and colours, and all the phenomena of visible objects. *See* PERSPECTIVE.

By a ray of light, is meant the motion of a single particle; and its motion is represented by a straight line. Any parcel of rays proceeding from a point, is called a pencil of rays. By a medium, is meant any pellucid or transparent body, which suffers light to pass through it. Thus, water, air, and glass, are called media. Parallel rays, are such as move always at the same distance from each other. If rays continually recede from each other, they are said to diverge. If they continually approach towards each other, they are said to converge. The point at which converging rays meet is called the focus. The point towards which they tend, but which they are prevented from coming to by some obstacle, is called the imaginary focus. When rays, after passing through one medium, on entering another medium of different density, are bent out of their former course, and made to change their direction, they are, said to be refracted. When they strike against a surface, and are sent back again from the surface, they are said to be reflected. A lens, is glass ground into such a form as to collect or disperse the rays of light which pass through it. These are of different shapes, and from thence receive different names. A plano convex is one side flat, and the other convex. A plano concave is flat on one side, and concave on the other. A double convex, is convex on both sides. A double concave, is concave on both sides. A meniscus, is convex on one side and concave on the other. A line passing through the centre of a lens, is called its axis.

*Of Refraction.*—If the rays of light, after passing through a medium, enter another of a different density perpendicular to its surface, they proceed through this medium in the same direction as before. But if they enter obliquely to the surface of a medium, either denser or rarer than what they moved in before, they are made to change their direction in passing through that medium. If the medium which they enter be denser, they move through it in a direction nearer to the perpendicular drawn to its surface. On the contrary, when light passes out of a denser into a rarer medium, it moves in a direction farther from the perpendicular. This refraction is greater or less, that is, the rays are more or less bent or turned aside from tneir course, as the second medium through which they pass is more or less dense than the first.

Upon a smooth board, about the centre C, (plate *Optics*, fig. 4.) describe a circle H O K P; draw two diameters of the circle, O P, H K, perpendicular to each other; draw A D M perpendicular to O P; cut off D T and C I equal to three-fourths D A; through T I, draw T I S, cutting the circumference in S; N S drawn from S perpendicularly upon O P, will be equal to D T, or three-fourths of D A. Then if pins be stuck perpendicularly at A, C, and S, and the board be dipped in the water as far as the line H K, the pin at S will appear in the same line with the pins at C and C. This shews, that the ray which comes from the pin S is so refracted at C, as to come to the eye along the line C A; whence the sine of incidence A D is to the sine of refraction N S, as 4 to 3. If other pins were fixed along C S, they would all appear in A C produced; which shews, that the ray is bent at the surface only. The same may be shewn at different inclinations of the incident ray, by means of a moveable rod turning upon the centre C, which always keeps the ratio of the sines A D, N S, as 4 to 3. Also the sun's shadow, coinciding with A C, may be shewn to be refracted in the same manner. The image L of a small object S, placed under water, is one-fourth nearer the surface than the object. And hence, the bottom of a pond, river, &c. is one-third deeper than it appears to a spectator.

To prove the refraction of light in a different way, take an upright empty vessel into a dark room; make a small hole in the window shutter, so that a beam of light may fall at the bottom at *a*, fig. 5, where you may make a mark. Then fill the basin with water, without moving it out of its place, and you will see that the ray, instead of falling upon *a* will fall upon *b*. If a piece of looking-glass be laid in the bottom of the vessel, the light will be reflected from it, and will be observed to suffer the same refraction as in coming in; only in a contrary direction. If the water be made a little muddy, by putting into it a few drops of milk, and if the room be filled with dust, the rays will be rendered much more visible.

*Of Reflection.*—When a ray of light falls upon any body, it is reflected so that the angle of incidence is equal to the angle of reflection; and this is the fundamental fact upon which all the properties of mirrors depend. Let a ray of light, passing through a small hole into a dark room, be reflected from a plane mirror, at equal distances from the point of reflection, the incident and the reflected ray will be at the same height from the surface. The same is found to hold in all cases when the rays are reflected at a curved surface, whether it be convex or concave.

The rays which proceed from any remote terrestrial object are nearly parallel at the mirror: not strictly so, but come diverging to it in several pencils, or, as it were, bundles of rays, from each point of the side of the object next the mirror, therefore they will not be converged to a point at the distance of half the radius of the mirror's concavity from its reflecting surface, but in separate points at a greater distance from the mirror. And the nearer the object is to the mirror, the further these points will be from it, and an inverted image of the object will be formed in them, which will seem to hang pendent in the air; and will be seen by an eye placed beyond it (with regard to the mirror,) in all respects like the object, and as distinct as the object itself.

If a man place himself directly before a large concave mirror, but further from it than its centre of concavity, he will see an inverted image of himself in the air, between him and the mirror, of a less size than himself. And if he hold out his hand toward the mirror, the hand of the image will come out towards his hand, and coincide with it, of an equal bulk, when his hand is in the centre of concavity, and he will imagine he may shake hands with his image. If he reach his hand further, the hand of the image will pass by his hand, and come between it and his body; and if he move his hand toward either side, the hand of the image will move towards the other: so that whatever way the object moves, the image will move the contrary way. A bystander will see nothing of the image, because none of the reflected rays that form it enter his eyes.

The images formed by convex specula are in positions similar to those of their objects; and those also formed by concave specula, when the object is between the surface and the principal focus; in these cases the image is only imaginary, as the reflected rays never come to the foci from whence they seem to diverge. In all other cases of reflection from concave specula, the images are in positions contrary to those of their objects, and these images are real, for the rays after reflection do come to their respective foci.

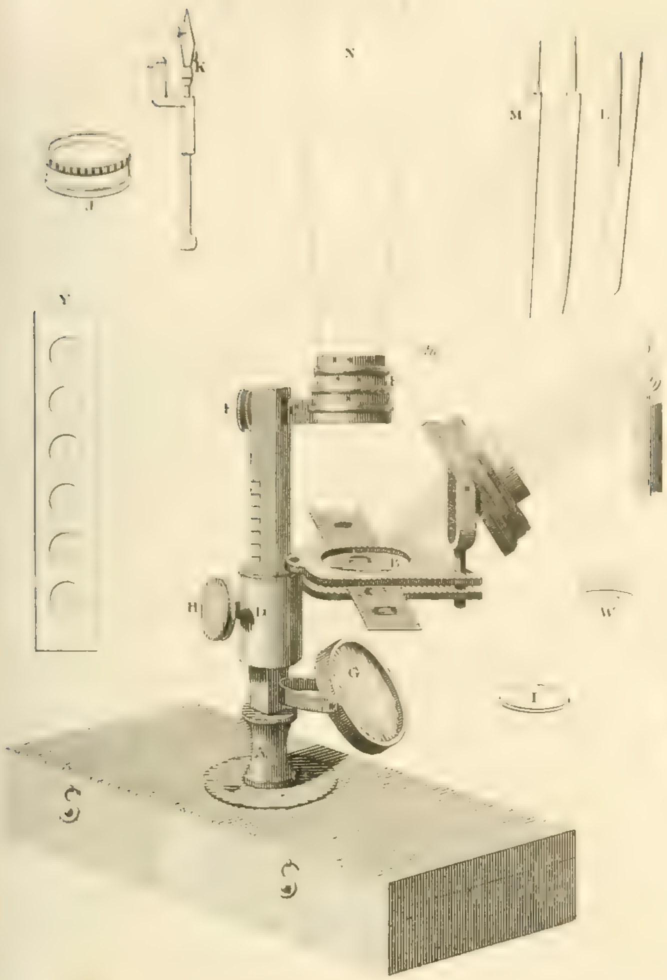
*Colours.*—The origin of colours is owing to the composition which takes place in the rays of light, each heterogeneous ray consisting of innumerable rays of different colours; this is evident from the separation that ensues in the well-known experiment of the prism. A ray being let into a darkened room, through a small round aperture, and falling on a triangular glass prism, is, by the refraction of the prism, considerably dilated, and will exhibit on the opposite wall an oblong image, called a spectrum, variously coloured, the extremities of which are bounded by semi-circles, and the sides are rectilinear. The colours are commonly divided into seven, which, however, have various shades gradually intermixing at their juncture. Their order, beginning from the side of the refracting angle of the prism, is red, orange, yellow, green, blue, purple, violet. The obvious conclusion from this experiment is, that the several component parts of solar light have different degrees of refrangibility, and that each subsequent ray in the order above mentioned is more refrangible than the preceding. As a circular image would be depicted by the solar ray unrefracted by the prism, so each ray that suffers no dilatation by the prism would mark out a circular image. Hence it appears that the spectrum is composed of innumerable circles of different colours. The mixture, therefore, is proportionable to the number of circles mixed together, but all such circles are mixed together, whose centres lie between those of two contingent circles, consequently the mixture is proportionable to the interval of those centres, *i. e.* to the breadth of the spectrum. If, therefore, the breadth can be diminished, retaining the length of the rectilinear sides, the mixture will be lessened proportionably, and this is done by the following process.

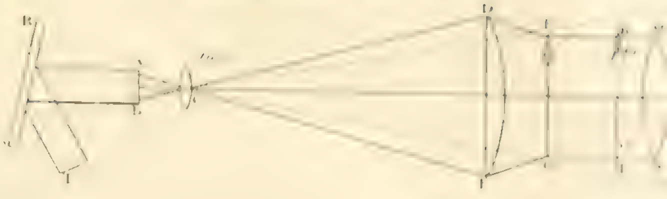
At a considerable distance from the hole *z*, place a double convex lens, fig. 6, whose focal length is equal to half that distance, and place the prism *x*, behind the lens; at a distance behind the lens, equal to the distance of the lens from the hole, will be formed a spectrum, the length of whose rectilinear sides is the same as before, but its breadth much less; for the undiminished breadth was equal to a line subtending, at the distance of the spectrum from the hole, an angle equal to the apparent diameter of the sun, together with a line equal to the diameter of the hole; but the reduced breadth is equal to the diameter of the hole only; the image of the hole formed by the lens at the distance of double its focal length, is equal to the hole; therefore, its several images in the different kinds of rays are equal to the same, *i. e.* the breadth of the reduced spectrum is equal to the diameter of the hole.

A prism placed in an horizontal position would project the ray into an oblong form; apply another horizontal prism similar to the former, to receive the refracted light emerging from the first, and having its refracted angle turned the contrary way from that of the former. The light, after passing through both prisms, will assume a circular form, as if it had not been at all refracted. If the light emerging from the first prism be received by a second, whose axis is perpendicular to that of the former, it will be refracted by this transverse prism into a position inclined to the former, the red extremity being least and the violet most removed from its former position; but it will not be at all altered in breadth.

Close to the prism A, fig. 7, place a perforated board *a b*, and let the refracted light, having passed through the small hole, be received on a second board *c d*, parallel to the first, and perforated in like manner; behind that hole in the second board place a prism, with its refracting angle downward; turn the first prism slowly about its axis, and the light will move up and down the second board; let the colours be transmitted successively, and mark the places of the different coloured rays on the wall after their refraction by the second prism, the red will appear lowest, the violet highest, the rest in the intermediate

# Optics





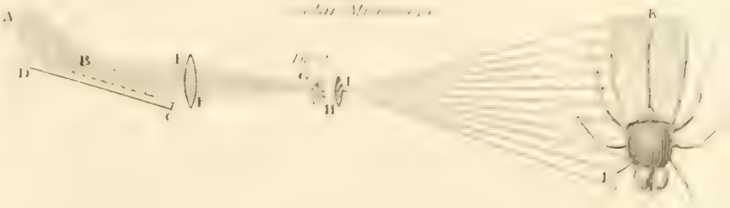
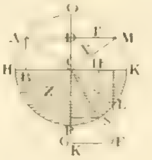
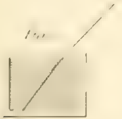


Fig. 4





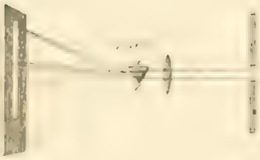
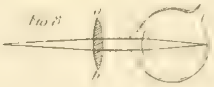


Fig. 8



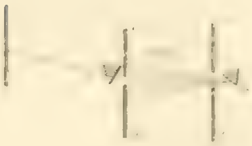


Fig. 9

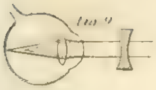


Fig. 10

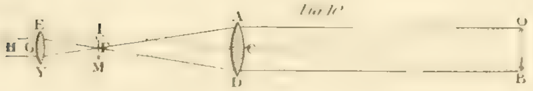
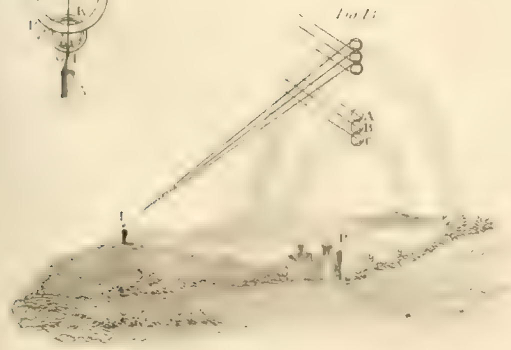
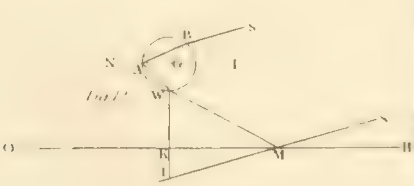
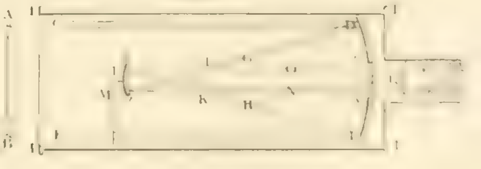
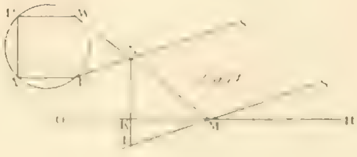


Fig. 13









places in order. Here then the light being very much simplified, and the incidences of all the rays on the second prism exactly the same; the red was least refracted, the violet most, &c.

The permanency of these original colours appears from hence, that they suffer no manner of change by any number of refractions, as is evident from the last mentioned experiment; nor yet by reflection, for if any coloured body be placed in simplified homogeneous light, it will always appear of the same colour as the light in which it is placed, whether that differ from the colour of the body or not; *e.g.* if ultramarine and vermilion be placed in red light, both will appear red; in a green light, green; in a blue light, blue, &c. It is however to be allowed, that a body appears brighter when in a light of its own colour than in another; and from this we see that the colours of natural bodies arise from an aptitude in them to reflect some rays more copiously and strongly than others; but lest this phenomenon should produce a doubt of the constancy of the primary colours, it is proper to assign the reason of it, which is this; that when placed in its own coloured light, the body reflects the rays of the predominant colour more strongly than any of those intermixed with it; therefore the proportion of the rays of the predominant colour to those of the others, in the reflected light, will be greater than in the incident light; but when the body is placed in a light of a different colour from its own, for a similar reason the contrary effect will follow, *i. e.* the proportion of the predominant colour to the others would be less in the reflected than in the incident light, and therefore as its splendour would be greater in the former case, and would be less in the latter, than if all the rays were effectually reflected, the splendour of the predominant colour will be much greater in the former case than in the latter. White is compounded of all the primary colours mixed in their due proportions, for if a solar ray be separated by the prism into its component, and at a proper distance a lens be so placed as to collect the diverging coloured rays again into a focus, a paper placed perpendicularly to the rays in this point will exhibit whiteness. The same conclusion may be drawn from the experiment of mixing together paints of the same colour as the parts of the spectrum, and in the same proportion; the mixture will be white, though not of a resplendent whiteness, because the colours mixed are less bright than the primary ones; this may likewise be proved, by fixing pieces of cloth of all the seven different colours on the rim of a wheel, and whirling it round with great velocity, it will appear to be white. Though seven different colours are distinguishable in the prismatic spectrum, yet upon examining the matter with more accuracy, we shall see that there are, in fact, only three original colours, red, blue, and yellow; for the orange being situated between the red and yellow, is only the mixture of these two; the green in like manner arises from the blue and yellow; and the violet from the blue and red. As the colour of a body therefore proceeds from a certain combination of the primary rays which it reflects; the combination of rays flowing from any point of an object will, when connected by a glass, exhibit the same compound colour in the corresponding point of the image. Hence appears the reason why the images formed by glasses have the colours of the object which they represent.

*Vision.*—Objects presented to the eye have their images painted on the back part of the retina, the rays of the incident pencils converging to their proper foci there by the refraction of the different humours; and for this office they are admirably adapted; for as the distance between the back and front of the eye is very small, and the rays of each of the pencils that form the image fall parallel, or else diverging on the eye, a strong refractive power is necessary for bringing them to their foci at the retina; but each of the humours, by its peculiar form and density, contributes to cause a convergence of the rays; the aqueous from its convex form; the crystalline by its double convexity and greater density than the aqueous; and the vitreous by a less density than the crystalline joined to its concave form. The structure of the eyes is in general adapted to the reception of parallel rays, but as the distances of visible objects are various, so the eye has powers of accommodating itself to rays proceeding from different distances by altering the distances of the crystalline from the retina, which is done by the action of the ciliary ligaments.

Defective sight arises from an incapacity of altering the position of the crystalline within the usual limits. 1. When it cannot be brought close enough to the cornea, near objects appear indistinct; to this defect people in years are generally subject. 2. Where the crystalline cannot be drawn sufficiently near to the retina, remote objects appear indistinct; this is the defect under which short-sighted people labour. In each of these cases the images of the different points in the object would be diffused over small circles on the retina: and so being intermixed and confounded with each other, would there form a very confused picture of the object: for in the former case, fig. 8, the image of any point would be formed behind the retina, as the refraction of the eye is not sufficiently strong to bring the rays (diverging so much as they do in proceeding from a near point) to a focus at the retina. This defect will therefore be remedied by a convex glass *a b*, fig. 8, which makes the point whence the rays now proceed more distant than the object; therefore the rays falling on the eye will now diverge less than before, or else be parallel, and will of course be brought to a nearer focus, *viz.* at the retina.

In the latter case, the image is formed before the retina, fig. 9, because the refractive power of the eye is too great to permit rays so little diverging (as they do in proceeding from a distant point) to reach the retina before they are collected into a focus: in this case, the defect is supplied by a concave glass, which makes the point whence the rays diverge, nearer than the object; consequently, the rays falling on the eye will now diverge more than before, so as when refracted through the humours not to come to their focus before they reach the retina. Therefore spectacles are constructed concave for short-sighted, and convex for long-sighted people. And the frames of spectacles should be so bent, that the axes of both glasses may be directed to one point, at such a distance as you generally look with spectacles; by this means the eyes will fall perpendicularly upon both glasses, and make the object appear distinct; whereas if they fall obliquely upon the glasses the object will appear confused and indistinct.

*Optical Instruments.*—The impediments to the vision of very near objects arise from too great a divergence of the rays in each pencil incident on the eye, and are remedied by the microscope.

*Microscopes.*—The most powerful single microscopes are very small globules of glass, which any curious person may make for himself by melting the ends of fine threads of glass in the flame of a candle; or by taking a little fine powdered glass on the point of a very small needle, and melting it into a globule in that way. It was with such microscopes as these that Lewenhoek made all his wonderful discoveries, most of which are deposited in the British Museum.

The Double or Compound Microscope differs from the preceding in this respect, that it consists of at least two lenses, by one of which an image is formed within the tube of the microscope; and this image is viewed through the eye-glass, instead of the object itself, as in the single microscope. In this respect the principle is analogous to that of the telescope, only that, as the latter is intended to view distant objects, the object-lens is of a long focus, and consequently of a moderate magnifying power, and the eye-glass of a short focus, which magnifies considerably the image made by the object lens. Whereas the microscope being intended only for minute objects, the object-lens is consequently of a short focus, and the eye-glass in this case is not of so high a magnifying power. We have explained this instrument under MICROSCOPE.

The Solar Microscope is a kind of camera obscura, which, in a darkened chamber, throws the image on a wall or screen. It consists of two lenses fixed opposite a hole in a board or windowshutter; one, which condenses the light of the sun upon the object, (which is placed between them,) and the other, which forms the image. There is also a plain reflector placed without, moved by a wheel and pinion, which may be so regulated as to throw the sun's rays upon the outer lens. Mr. Adam's most ingenious invention, the lucernal microscope, is also to be considered as a kind of camera obscura; only the light in this latter case proceeds from a lamp, instead of from the sun, which renders it convenient to be used at all times. But for a description of this elegant and most amusing instrument, we must refer to his Microscopical Essay. *See* Microscope.

*Telescopes.*—From what has been said on the nature of the compound microscope, the principle of the telescope may be easily understood. Telescopes are, however, of two kinds; the one depending on the principle of refraction, and called the dioptric telescope; the other, on the principle of reflection, and therefore termed the reflecting telescope.

The parts essential to a dioptric telescope are, the two lenses A D and E Y, fig. 10. As in the compound microscope, A D is the object-glass, and E Y is the eye-glass; and these glasses are so combined in the tube, that the focus F of the one is exactly coincident with the focus of the other. Let O B then represent a very distant object, from every point of which pencils of rays will proceed, so little diverging to the object lens A D, that they may be considered as nearly parallel; I M will then be the image which would be formed on a screen by the action of the lens A D. For supposing O A and B D two pencils of rays proceeding from the extreme points of the object, they will unite in the focal point F, and intersect each other. But the point F is also the focus of the eye-glass E Y; and therefore the pencil of rays, instead of going on to diverge, will pass through it in nearly a parallel direction, so as to cause distinct vision. It is then plain, that as in the compound microscope, it is the image which is here contemplated; and this will account for the common sensation when people say the object is brought nearer by a telescope. For the rays, which after crossing proceed in a divergent state, fall upon the lens E Y, as if they proceeded from a real object situated at F. All that is effected by a telescope then, is to form such an image of a distinct object, by means of the object lens, and then to give the eye such assistance as is necessary for viewing that image as near as possible, so that the angle it shall subtend at the eye shall be very large compared with the angle which the object itself would subtend in the same situation. This is effected by means of the eye-glass, which refracts the pencils of rays, so that they may be brought to their several foci by the humours of the eye, as has been described. To explain clearly, however, the reason why it appears magnified, we must again have recourse to the figure. O B being at a great distance, the length of the telescope is inconsiderable with respect to it. Supposing, therefore, the eye viewed it from the centre of the object-glass C, it would see it under the angle O C B; let O C and B C then be produced to the focus of the glass, they will then limit the image I M formed in the focus. If then two parallel rays are supposed to proceed to the eye-glass E Y, they will be converged to its focus H; and the eye will see the image under the angle E H Y. The apparent magnitude of the object seen by the naked eye, is, therefore, to that of the image which is seen through the telescope, as the magnitude of the angle O C B, or I C M, to that of E H Y, or I G M. Now, the angle I G M is to I C M as C F to F G; that is, as the focal length of the object-glass to that of the eye-glass.—The magnifying power of these glasses may be augmented to a considerable degree, because the focal length of the object-glass, with respect to that of the eye-glass, may be greatly increased. This, however, would require a tube of immense length; because an eye-glass of a very short focus would cause such a dispersion of the rays of light, particularly towards the edges of the glass, that the view would be intercepted by the prismatic colours. Another manifest defect in these telescopes is, that the image appears inverted; this, however, is of no consequence with respect to the heavenly bodies; and on this account it is still used as an astronomical telescope. One of almost a similar construction is also used on board of ships as a night glass, to discover rocks in the ocean, or an enemy's fleet. Notwithstanding the inconvenience of exhibiting the objects inverted, more glasses than two cannot be employed from the paucity of light; and habit soon enables the persons who use them to discern objects with tolerable distinctness. The brightness of the appearance through any of these telescopes or microscopes, depends chiefly on the aperture of the object-glass. For if the whole of that glass was covered, except a small aperture in the middle, the magnitude of the image would not be altered; but fewer rays of every pencil being admitted, the object would appear obscure. In a few words, the apparent distinctness or confusion of any object, viewed through glasses, depends on the mutual inclination of the rays in any one pencil to each other, when they fall on the eye; the apparent magnitude depends upon the inclination of the rays of different pencils to each other; the apparent situation depends upon the real situation of the extreme pencils; and the apparent brightness or obscurity depends on the quantity of rays in each pencil.

The well-known property in concave speculums, of causing the pencils of rays to converge to their foci, and there forming an image of any object that may be opposed to them, gave rise to the reflecting telescope. In this, the effect is precisely the same as that produced by the dioptric telescope; only that in the one case it is produced by reflected, and in the other by refracted light. Reflecting telescopes are made in various forms; and those principally in use in this country are distinguished by the names of their respective inventors, and are called the Newtonian, Gregorian, and Herschelian telescopes. The reflecting telescopes on the Gregorian principle, which is the most common, as it is found to be the most convenient, is constructed in the following manner:—At the bottom of the great tube, fig. 11, T T T T, is placed a large concave mirror D U V F, whose principal focus is at *m*; and in the middle of this mirror is a round hole P, opposite to which is placed the small mirror L, concave toward the great one, and so fixed to a strong wire M, that it may be removed further from the great mirror, or nearer to it, by means of a long screw in the inside of the tube, keeping its axis still in the same line P *m n* with that of the great one. Now, since in viewing a very remote object, we can scarcely see a point of it but what is, at least, as broad as the great mirror, we may consider the rays of each pencil, which flow from every point of the object, to be parallel to each other, and to cover the whole reflecting surface D U V F. But to avoid confusion in the figure, we shall only draw two rays of a pencil flowing from each extremity of the object into the great tube, and trace their progress through all their reflections and refractions to the eye *f*, at the end of the small tube *t t*, which is joined to the great one. Let us then suppose the object A B to be at such distance, that the rays C may flow from its upper extremity A, and the rays E from its lower extremity B; then the rays C falling parallel upon the great mirror at D, will be thence reflected, converging in the direction D G; and by crossing at I in the principal focus in the mirror, they will form the lower extremity of the inverted image I K, similar to the upper extremity A of the object A B; and passing on to the concave mirror L, (whose focus is at *n*,) they will fall upon it at *g*, and be thence reflected, converging in the direction *g* N, because *g m* is longer than *g n;* and passing through the hole P in the large mirror, they would meet somewhere about *r*, and form the upper extremity *a* of the erect image *a b*, similar to the upper extremity A of the object A B. But by passing through the plano-convex glass R, in their way, they form that extremity of the image at *a*. In the same manner the rays E, which come from the bottom of the object A B, and fall parallel upon the great mirror at F, are thence reflected, converging to its focus; where they form the upper extremity I of the inverted image I K, similar to the lower extremity B of the object A B; and thence passing on the small mirror L, and falling upon it at *h*, they are hence reflected in the converging state *h* O; and going on through the hole P of the great mirror, they would meet somewhere about *q*, and form there the lower extremity *b* of the erect image *a b*, similar to the lower extremity B of the object A B; but by passing through the convex glass R in their way, they meet and cross sooner, as at *b*, where the point of the erect image is formed. The like being understood of all those rays which flow from the intermediate points of the object between A and B, and enter the tube T T, all the intermediate points of the image between *a* and *b* will be formed; and the rays passing on from the image through the eye-glass S, and through a small hole *e* in the end of the lesser tube *t t*, they enter the eye *f*, which sees the image *a b* (by means of the eye-glass) under the large angle *c e d*, and magnified in length under that angle from *c* to *d*.

In the best reflecting telescopes the focus of the small mirror is never coincident with the focus *m* of the great one, where the first image I K is formed, but a little beyond it, (with respect to the eye) as at *n*; the consequence of which is, that the rays of the pencils will not be parallel after reflection from the small mirror, but converge so as to meet in points about *q*, *e*, *r*; where they would form a larger upright image than *a b*, if the glass R was not in their way, and this image might be viewed by means of a single eye-glass properly placed between the image and the eye; but then the field of view would be less, and consequently not so pleasant; for that reason the glass R is still retained, to enlarge the scope or area of the field.

To find the magnifying power of this telescope, multiply the focal distance of the great mirror by the distance of the small mirror from the image next the eye, and multiply the focal distance of the small mirror by the focal distance of the eye-glass; then divide the product of the former multiplication by that of the latter, and the quotient will express the magnifying power. The difference between the Newtonian and Gregorian telescope is, that in the former the spectator looks in at the side through an aperture upon a plane mirror, by which the rays reflected from the concave mirror are reflected to the eye-glass; whereas, in the latter, the reader will see that he looks through the common eye-glass, which is in general more convenient.

The immensely powerful telescopes of Dr. Herschel are of a still different construction. This assiduous astronomer made several specula, which were of an immense magnifying power on distant objects. The object is reflected by a mirror, as in the Gregorian telescope, and the rays are intercepted by a lens at a proper distance, so that the observer has his back to the object, and looks through the lens at the mirror. The magnifying power will, in this case, be the same as in the Newtonian telescope; but there not being a second reflector, the brightness of the object viewed in the Herschelian is greater than that in the Newtonian or Gregorian telescope. In conclusion, Sir Isaac Newton's excellent maxim must not be omitted: "The art," says he, "of constructing good microscopes and telescopes, may be said to depend on the circumstance of making the last image as large and distinct and luminous as possible." *See* TELESCOPE.

*Of the Rainbow, and other remarkable Optical Phenomena.*—Since the rays of light are found to be decompounded by refracting surfaces, we can no longer be surprised at the changes produced in any object by the intervention of another. The vivid colours which gild the rising or the setting sun, must necessarily differ from those which adorn its noon-day splendour. There must be the greatest variety which the liveliest fancy can imagine. The clouds will assume the most fantastic forms, or will lower with the darkest hues, according to the different rays which are reflected to our eyes, or the quantity absorbed by the vapours in the air. The ignorant multitude will necessarily be alarmed by the sights in the heavens; by the appearance at one time of three, at another of five, suns; or circles of various magnitudes round the sun or moon; and thence conceive that some fatal change in the physical or the moral world, some fall of empires, or tremendous earthquake; while the optician contemplates them merely as the natural and beautiful effects produced by clouds or vapour, in various masses, upon the rays of light. One of the most beautiful and common of these appearances deserves particular investigation, as, when this subject is well understood, there will be little difficulty in accounting for others of a similar nature, dependent on the different refrangibility of the rays of light. Frequently, when our backs are turned to the sun, and there is a shower either around us, or at some distance before us, a bow is seen in the air, adorned with all or some of the seven primary colours. The appearance of this bow, which in poetical language is called the iris, and in common language the rainbow, was an inexplicable mystery to the ancients; and, though now well understood, continues to be the subject of admiration to the peasant and the philosopher.

We are indebted to Sir Isaac Newton for the explanation of this appearance; and by various easy experiments, we may convince any man that his theory is founded on truth. If a glass globe is suspended in the strong light of the sun, it will be found to reflect the different prismatic colours exactly in proportion to the position in which it is placed; in other words, agreeably to the angle which it forms with the spectator's eye, and the incidence of the rays of light. The fact is, that innumerable pencils of light fall upon the surface of the globe, and each of these is separated as by a prism. To make this matter still clearer, let us suppose the circle B A W, fig. 12, to represent the globe, or a drop of rain, for each drop may be considered as a small globe of water. The red rays, it is well known, are least refrangible; they will therefore be refracted, agreeably to their angle of incidence, to a certain point A in the most distant part of the globe; the yellow, the green, the blue, and the purple rays, will each be refracted to another point. A part of the light, as refracted, will be transmitted, but a part will also be reflected; the red rays at the point A, and the others at certain other points, agreeably to their angle of refraction. It is very evident, that if the spectator's eye is placed in the direction of M W, or the course of the red-making rays, he will only distinguish the red colour; if in another situation, he will see only by the yellow rays; in another, by the blue, &c.; but, as in a shower of rain there are drops at all heights and all distances, all those that are in a certain position with respect to the spectator, will reflect the red rays, all those in the next station the orange, those in the next the green, &c. To avoid confusion, let us for the present imagine only three drops of rain, and three degrees of colours in the section of the bow, fig. 13. It is evident, that the angle C E P is less than the angle B E P, and that the angle A E P is the greatest of the three. This largest angle then is formed by the red rays, the middle one consists of the green, and the smallest is the purple. All the drops of rain, therefore, that happen to be in a certain position to the eye of a spectator, will reflect the red rays, and form a band or semicircle of red; those again in a certain position will present a band of green, &c. If he alters his station, the spectator will see a bow, though not the same bow as before: and if there are many spectators, they will each see a different bow, though it appears to be the same.

There are sometimes seen two bows, one formed as has been described, the other appearing externally to embrace the primary bow, and which is sometimes called the secondary or false bow, because it is fainter than the other, and what is most remarkable is, that in the false bow the order of the colours appears always reversed. In the true or primary bow we have seen that the rays of light arrive at the spectator's eye after two refractions and one reflection; in the secondary bow the rays are sent to our eyes after two refractions and two reflections, and the order of the colours is reversed, because in this latter case the light enters at the inferior part of the drop, and is transmitted through the superior. Thus, fig. 12, the ray of light which enters at B, is refracted to A, whence it is reflected to P, and again reflected to W, where, suffering another refraction, it is sent to the eye of the spectator. The colours of this outer bow are fainter than those of the other, because the drop being transparent, a part of the light is transmitted, and consequently lost at each reflection.

The phenomenon assumes a semicircular appearance, because it is only at certain angles that the refracted rays are visible to our eyes. The least refrangible, or red rays, make an angle of 42 degrees two minutes, and the most refrangible or violet rays an angle of 40 degrees 17 minutes. Now, if a line be drawn horizontally from the spectator's eye, it is evident, that angles formed with this line, of a certain dimension in every direction, will produce a circle; as will be evident, by only attaching a cord of a given length to a certain point, round which it may turn as round its axis, and in every point will describe an angle with the horizontal line of a certain and determinate extent. Let H O, for instance, fig. 14, represent the horizon, B W a drop of rain at any altitude, S B a line drawn from the sun to the drop, which will be parallel to a line S M drawn from the eye of the spectator to the sun. The course of part of the decompounded ray S B may be first by refraction from B to A, then by reflection from A to W; lastly, by refraction from W to M. Now, all drops, which are in such a situation that the incident and emergent rays S B, M W, produced through them, make the same angle S N M, will be the means of exciting in the spectators the same idea of colour. Let M W turn upon H O as an axis, till W meets the horizon on both sides, and the point W will describe the arc of a circle; and all the drops placed in its circumference will have the property we have mentioned, of transmitting to the eye a particular colour. When the plane H M W A is perpendicular to the horizon, the line M W is directed to the vertex of the bow, and W K is its altitude. This altitude depends on two things, the angle between the incident and emergent rays, and the height of the sun above the horizon; for since S M is parallel to S N, the angle S N M is equal to N M I; but S M H, the altitude of the sun, is equal to K M I; therefore the altitude of the bow W M K, which is equal to the difference between W M I and K M I, is equal to the difference between the angles made by the incident and emergent rays and the altitude of the sun. The angle between the incident and emergent rays is different for the different colours, as was already intimated; for the red, or least refrangible, rays, it is equal to 42 degrees 2 minutes; for the violet or most refrangible, it is equal to 40 degrees 17 minutes; consequently, when the sun is more than 42 degrees 2 minutes above the horizon, the red colour cannot be seen; when it is above 40 degrees 17 minutes, the violet colour cannot be seen. The secondary bow is made in a similar manner; but the sun's rays suffer, in this case, two reflections within the drop. The ray S B, fig. 14, is decompounded at B; and one part is refracted to A, thence reflected to P, and from P reflected to W, where it is refracted to M. The angle between the incident and emergent rays S N M is equal as before to N M I; and N M K, the height of the bow, is equal to the difference between the angle made by the incident and emergent rays and the height of the sun. In this case the angle S N M, for the red rays, is equal to 50 degrees 7 minutes, and for the violet rays it is equal to 54 degrees 7 minutes, consequently the upper part of the secondary bow will not be seen when the sun is above 54 degrees 7 min. above the horizon, and the lower part of the bow will not be seen when the sun is 50 degrees 7 minutes above the horizon.

In the same manner innumerable bows might be formed by a greater number of reflections within the drops; but as the secondary is so much fainter than the primary, that all the colours in it are seldom seen; for the same reason a bow made with three reflections would be fainter still, and in general altogether imperceptible. Since the rays of light, by various reflections and refractions, are thus capable of forming, by means of drops of rain, the bows which we so frequently see in the heavens, it is evident that there will be not only solar and lunar bows, but that many striking appearances will be produced by drops upon the ground or air, on the agitated surface of the water. Thus a lunar bow will be formed by rays from the moon affected by drops of rain; but as its light is very faint in comparison with that of the sun, such a bow will very seldom be seen, and the colours of it when seen will be faint and dim.

The marine or sea bow is a phenomenon sometimes observed in a much agitated sea; when the wind, sweeping part of the tops of the waves, carries them aloft, so that the sun's rays, falling upon them, are refracted, &c. as in a common shower, and paint the colours of the bow. Rohault mentions coloured bows on the grass, formed by the refraction of the sun's rays in the morning dew. Dr. Langwith, indeed, once saw a bow lying on the ground, the colours of which were almost as lively as the common rainbow. It was extended several hundred yards. It was not round, but oblong, being, as he conceived, the portion of an hyperbola. The colours took up less space, and were much more lively, in those parts of the bow which were near him than in those which were at a distance.

The drops of rain descend in a globular form, and thence we can easily account for the effects produced by them on the rays of light; but in different states of the air, instead of drops of rain, vapour falls to the earth in different forms of sleet, snow, and hail. In the two latter states there cannot be a refraction of the rays of light; but in the former state, when a drop is partly in a congealed and partly in a fluid form, the rays of light will be differently affected, both from the form of the drop and its various refracting powers. Hence we may expect a variety of curious appearances in the heavens; and to those drops, in different states, we may attribute the formation of halos, parhelia, and many other phenomena, detailed in the Philosophical Transactions, or in the histories of every country.

The halo, or corona, is a luminous circle surrounding the sun, the moon, a planet, or a fixed star. It is sometimes quite white, and sometimes coloured like the rainbow. Those which have been observed round the moon or stars are but of a very small diameter; those round the sun are of different magnitudes, and sometimes immensely great. When coloured, the colours are fainter than those of the rainbow, and appear in a different order, according to their size. In those which Sir Isaac Newton observed in 1692, the order of the colours, from the inside next the sun, was in the innermost blue, white, red; in the middle purple, blue, green, yellow, pale red; in the outermost pale blue, and pale red. Huygens observed one red next the sun, and pale blue at the extremity. Mr. Weidler has given an account of one yellow on the inside, and white on the outside. In France one was observed, in which the order of the colours was white, red, blue, green, and a bright red on the outside.

Artificial coronas may be made in cold weather, by placing a lighted candle in the midst of a cloud of steam; or if a glass window is breathed upon, and the flame of a candle placed at some distance from the window, while the operator is also at the distance of some feet from another part of the window, the flame will be surrounded with a coloured halo.

The parhelia, or mock suns, are the most splendid appearances of this kind. The parhelia generally appear about the size of the true sun, not quite so bright, though they are said sometimes to rival their parent luminary in splendour. When there are a number of them, they are not equal to each other in brightness. Externally they are tinged with colours like the rainbow. They are not always round, and have sometimes a long fiery tail opposite the sun, but paler towards the extremity. Dr. Haller observed one with tails extending both ways. Mr. Weidler saw a parhelion with one tail pointing up and another downward, a little crooked; the limb which was farthest from the sun being of a purple colour, the other tinged with the colours of the rainbow.

Coronas generally accompany parhelia: some coloured, and others white. There is also, in general, a very large white circle, parallel to the horizon, which passes through all the parhelia; and if it was entire, would go through the centre of the sun: sometimes there are arches of smaller circles concentric to this, and touching the coloured circles which surround the sun; they are also tinged with colours, and contain other parhelia. One of the most remarkable appearances of this kind was that which was observed at Rome by Scheiner, as intimated above; and this may serve as a sufficient instance of the parhelion.

This celebrated phenomenon is represented in fig. 15, in which A is the place of the observer, B his zenith, C the true sun, and A B a plane passing through the observer's eye, the true sun, and the zenith. About the sun C there appeared two concentric rings, not complete, but diversified with colours. The lesser of them D E F, was fuller and more perfect; and though it was open from D to F, yet those ends were perpetually endeavouring to unite, and sometimes they did so. The outer of these rings was much fainter, so as scarcely to be discernible. It had, however, a variety of colours, but was very inconstant. The third circle, K L M N, was very large, and entirely white, passing through the middle of the sun, and every where parallel to the horizon. At first this circle was entire; but towards the end of the phenomenon it was weak and ragged, so as hardly to be perceived from M towards N. In the intersection of this circle and the outward iris G K I, there broke out two parhelia, or mock suns, N and K, not quite perfect, K being rather weak, but N shone brighter and stronger. The brightness of the middle of them was something like that of the sun; but towards the edges they were tinged with colours like those of the rainbow, and were uneven and ragged. The parhelion N was a little wavering: and sent out a spiked tail N P, of a colour somewhat fiery, the length of which was continually changing. The parhelia at L and M, in the horizontal ring, were not so bright as the former, but were rounder, and white, like the circle in which they were placed. The parhelion N disappeared before K; and while M grew fainter, K grew brighter, and vanished the last of all. It is to be observed farther, that the order of the colours in the circles D E F, G K N, was the same as in the common halos, namely, red next the sun; and the diameter of the inner circle was also about 45 deg., which is the usual size of a halo. Parhelia have been seen for one, two, three, and four hours together; and in North America they are said to continue some days, and to be visible from sun-rise to sun-set. When they disappear it sometimes rains, or snow falls in the form of oblong spiculæ.

At Churchill, in Hudson's Bay, the rising of the sun is always preceded by two long streams of red light, which rise as the sun rises; and as they grow longer, begin to bend towards each other, till they meet directly over the sun, forming there a kind of parhelion or mock sun. These two streams of light seem to have their source in two other parhelia, which rise with the true sun; and in the winter season, when the sun never rises above the haze or fog which is constantly found near the horizon, all these accompany him the whole day, and set with him in the same manner as they rise. A fourth parhelion may sometimes be seen under the true sun; but this is not common. The cause of these is apparently the reflection of the sun's light and image from the thick and frozen clouds in the northern atmosphere, accompanied also with some degree of refraction. To enter upon a mathematical analysis of these phenomena would be only tedious, and very foreign to our purpose. From what has been said upon this subject, it is evident that all the phenomena of colours depend upon two properties of light, the refrangibility and reflexibility of its rays.

*Of the Inflection of Light.*—The direction of the rays of light is changed, as we have seen, in their approach to certain bodies by reflection and refraction; and consequently we must admit that there is some power in these bodies by which such effects are universally produced. If reflection was produced simply by the impinging of particles of light on hard or elastic bodies, or if they were in themselves elastic, the same effects would follow as in the impulse of other elastic bodies; but the angle of incidence could not be equal to the angle of reflection, unless the particles of light were perfectly elastic, or the bodies on which they impinged were perfectly elastic. Now we know that the bodies on which these particles impinge are not perfectly elastic; and also that if the particles of light were perfectly elastic, the diffusion of light from the reflecting bodies would be very different from its present appearance: for as no body can be perfectly polished, the particles of light, which are so inconceivably small, would be reflected back by the inequalities on the surface in every direction; consequently we are led to this conclusion, that the reflecting bodies are possessed of a power which acts at some little distance from their surfaces.

If this reasoning is allowed to be just, it necessarily follows, that if a ray of light, instead of impinging on a body, should pass so near to it as to be within the sphere of that power which the body possesses, it must necessarily suffer a change in its direction. Actual experiments confirm the truth of this position; and to the change in the direction of a particle of light, owing to its nearness to a body, we give the name of inflection.

From one of these experiments, made by Sir Isaac Newton, the whole of this subject will be easily understood. At the distance of two or three feet from the window of a darkened room, in which was a hole three-fourths of an inch broad to admit the light, he placed a black sheet of pasteboard, having in the middle a hole about a quarter of an inch square, and behind the hole the blade of a sharp knife, to intercept a small part of the light which would otherwise have passed through the hole. The planes of the pasteboard and blade were parallel to each other; and when the pasteboard was removed at such a distance from the window, as that all the light coming into the room must pass through the hole in the pasteboard, he received what came through this hole on a piece of paper two or three feet beyond the knife, and perceived two streams of faint light shooting out both ways from the beam of light into the shadow. As the brightness of the direct rays obscured the fainter light, by making a hole in his paper he let them pass through, and had thus an opportunity of attending closely to the two streams, which were nearly equal in length, breadth, and quantity of light. That part which was nearest to the sun's direct light was pretty strong for the space of about a quarter of an inch, decreasing gradually till it became imperceptible; and at the edge of the knife it subtended an angle of about twelve, or, at most fourteen degrees. Another knife was then placed opposite to the former, and he observed, that when the distance of their edges was about the four-hundredth part of an inch, the stream divided in the middle, and left a shadow between the two parts, which was so dark, that all light passing between the knives seemed to be bent aside to one knife or the other; as the knives were brought nearer to each other, this shadow grew broader, till upon the contact of the knives the whole light disappeared.

Pursuing his observations upon this appearance, he perceived fringes, as they may be termed, of different-coloured light, three made on one side by the edge of one knife, and three on the other side by the edge of the other: and thence concluded, that as in refraction the rays of light are differently acted upon, so are they at a distance from bodies by inflection; and by many other experiments of the same kind he supported his position, which is confirmed by all subsequent experiments. We may naturally conclude, that from this property of inflection some curious changes will be produced in the appearance of external objects. If we take a piece of wire of a less diameter than the pupil of the eye, and place it between the eye and a distant object, the latter will appear magnified, (fig. 16.) Let A be a church-steeple, B the eye, C the wire. The rays by which the steeple would have been otherwise seen are intercepted by the wire; and it is now seen by inflected rays, which make a greater angle than the direct rays, and consequently the steeple will be magnified.

*Optical Wonder.*—Mr. Scoresby's Journal of a Voyage to the Northern Whale Fishery, recently published, contains much information respecting the refractions which are usual in high latitudes: one very singular instance deserves to be noticed. "On my return to the ship, about eleven o'clock, the night was beautifully fine, and the air quite mild. The atmosphere, in consequence of its warmth, being in a highly refractive state, a great many curious appearances were presented by the land and ice-bergs. The most extraordinary effect of this state of the atmosphere, however, was the distinct inverted image of a ship in the clear sky, over the middle of the large bay or inlet before mentioned; the ship itself being entirely beyond the horizon. Appearances of this kind I have before noticed, but the peculiarities of this were—the perfection of the image, and the great distance of the vessel that it represented. It was so extremely well defined, that when examined with a telescope by Dolland, I could distinguish every sail, the general 'rig of the ship,' and its particular character: insomuch, that I confidently pronounced it to be my father's ship, the Fame, which it afterwards proved to be; though, on comparing notes with my father, I found that our relative position at the time, gave our distance from one another very nearly thirty miles beyond the horizon, and some leagues beyond the limit of direct vision. I was so struck by the peculiarity of the circumstance, that I mentioned it to the officer of the watch, stating my full conviction that the Fame was then cruising in the neighbouring inlet."

In nearly shutting the eyes and looking at a candle, there appear rays of light extending from it in various directions, like comets' tails; for the light, in passing through the eyelashes, is inflected; and consequently many separate beams will be formed, diverging from the luminous object. The power of bodies to inflect the rays of light passing near to them will produce different effects, according to the nature of the rays acted upon; consequently a separation will take place in the differently refrangible ray, and those fringes which were taken notice of by Sir Isaac Newton will appear in other objects, which are seen by the means of inflected rays. From considering thus the action of bodies upon light, we come to this general conclusion, for which we are indebted to our great philosopher—that light, as well as all other matter, is acted upon at a distance; and that reflection, refraction, and inflection, are owing to certain general laws in the particles of matter, which are equally necessary for the preservation of the beautiful harmony in the objects nearest to us, and to produce by their joint action that great law by which the greater bodies in their system are retained in their respective orbits.

*Table of Illuminating Power of Candles.*—To ascertain the illuminating power of different sorts of candles, first weigh one of each sort to be tried; light them all at the same instant; and after the lapse of any given time, say half an hour, extinguish and again weigh them: compare how much each has lost in weight; that which has lost most, is the sort which affords the strongest light. In order farther to know the comparative expense of burning candles of different kinds, and of various sizes, the reader may consult the following table, which presents the average result of a series of experiments made with a view to the determination of this point:—

| Description of wick. | Number of candles to the lb. | Weight of one candle. | | Length of time one candle will burn. | | Time that a pound will last. | | Expense of burning candles of each description, taking as a suppositive price 10s. per doz. in farthings and 100th parts, whence may easily be deduced the proportional expense, when they are at any other price. |
|---|---|---|---|---|---|---|---|---|
| | | *oz.* | *dr.* | *h.* | *m.* | *h.* | *m.* | |
| Small wick | 18 | — | 14 | 3 | 15 | 59 | 25 | 8·078 |
| | 18 | — | 13½ | 2 | 40 | 50 | 33 | 9·475 |
| Large wick | 16 | — | 15½ | 2 | 40 | 44 | — | 10·909 |
| | 12 | 1 | 5¼ | 3 | 27 | 41 | 32 | 11·557 |
| | 10 | 1 | 8 | 3 | 36 | 38 | 22 | 12·511 |
| | 7 | 2 | 1 | 4 | 9 | 32 | 12 | 14·907 |
| | 8 | 2 | — | 4 | 15 | 34 | — | 14·118 |
| | 5 | 2 | 13 | 5 | 19 | 30 | 12 | 15·894 |
| Mould Candles, at 12*s*. per dozen. | | | | | | | | |
| | 5 | 2 | 12 | 7 | 20 | 42 | 40 | 13·502 |
| | 4 | 4 | — | 9 | 3 | 36 | 12 | 15·911 |
| | 3 | 5 | 2 | 17 | 30 | 54 | 4 | 10·654 |

OPTIC *Inequality*, in Astronomy, is an apparent irregularity in the motions of the planets and other celestial bodies, being thus called, because it does not arise from any real inequality of the moving body, but from the situation of the eye of the observer.

OPTIC *Nerves*, the second pair of nerves springing from the crura of the medulla oblongata, and passing thence to the eye.

OPTIC *Place* of a planet, is its place as seen by the eye.

OPTIC *Pyramid*, is a pyramid formed by the visual rays proceeding from the eye, and passing through the extremities of any picture, when these rays are continued to terminate in a plane perpendicular to the observer.

OPTION, the power or faculty of wishing or choosing, or the choice a person makes of any thing. Hence we say, when a new suffragan bishop is consecrated, the archbishop of the province, by a customary prerogative, claims the collation of the first vacant benefice or dignity in that see; this is the bishop's option.

OR, *Gold*, in Heraldry, denoted by small points all over the field, in engravings of arms; and it is supposed to signify of itself generosity, splendour, or solidity.

ORANGE. *See* CITRUS.

ORATORIO, a sort of sacred drama, in dialogue, recitative, duettos, trios, ritornellos, and choruses; the subjects being usually taken from scripture, and the music being in the finest taste, and best chosen strains. Lent is the season for performances of this description.

ORBIS MAGNUS, the great orb in which the sun was supposed to revolve.

ORBIT, the path of any celestial body. The orbits of the several planets were, even after the restoration of the Pythagorean system of astronomy by Copernicus, supposed to be circular, having the sun in their common centre, which, indeed, was such a rational and simple hypothesis, that it is not at all singular both Copernicus and Kepler, as well as other astronomers of that day, were so unwilling to give up this idea. However, Kepler, after an immense number of observations upon the planet Mars, found that it was impossible to reconcile his observations with that theory, and he therefore abandoned it; but now, though he changed the figure from a circle to an ellipse, he still, by supposing the sun in the centre, found nearly the same difficulty in accounting for some of the observed phenomena. At length, however, it happily occurred to him to place the sun in one of the foci, with which position every observed irregularity perfectly agreed; and by that perseverance, for which he is so eminently distinguished, he came finally to those fundamental laws which still bear his name, *viz.*—1. The planets all revolve in elliptic orbits situated in planes passing through the centre of the sun, the latter body occupying one of the foci of the ellipse. 2. Equal areas are described in equal times. That is, if a line be supposed to join the central and revolving body, that line passes over or describes equal areas in equal times. 3. The squares of the times of revolution in planetary bodies, are as the cubes of their distances from the sun.

ORCHARD, a plantation of fruit trees. In planting an orchard great care should be taken that the soil is suitable to the trees planted in it; and that they are procured from a soil nearly of the same kind, ar rather poorer than that laid out for an orchard. As to the situation, an easy rising ground, open to the south-east, is to be preferred. Miller recommends planting the trees fourscore feet asunder, but not in regular rows; and would have the ground between the trees ploughed, and sown with wheat and other crops, in the same manner as if it was clear from trees; by which means the trees will be more vigorous and healthy, will abide much longer, and produce better fruit. If the ground has been pasture, the greensward should be ploughed in the spring before the trees are planted; and if it is suffered to lie a summer fallow, it will greatly mend it, provided it is stirred two or three times to rot the grass, and prevent the growing of weeds. At Michaelmas it should be ploughed pretty deep, in order to make it loose for the roots of the trees, which, if the soil is dry, should be planted in October; but if it is moist, the beginning of March will be a better season. If several sorts of fruit trees are to be planted on the same spot, you should observe to plant the largest growing trees backwards, and so proceed to those of less growth, continuing the same method quite through the whole plantation; by which means the sun and air will more easily pass through the whole orchard. When you have planted the trees, you should support them with stakes, to prevent their being blown out of the ground by the wind; and the following spring, if the season should prove dry, cut a quantity of green turf, and lay it about the roots, with the grass downwards; by which means a greater expense of watering will be saved, and after the first year they will be out of danger. Whenever you plough the ground betwixt these trees, you must be careful not to go too deep amongst their roots, which would greatly damage the tree; but if you do it cautiously, your stirring the face of the ground will be of great service to them; though you should observe never to sow too near the tree, nor to suffer any great rooting weeds to grow about them; because this would starve them, by exhausting the goodness of the soil, which every two or three years should be mended with dung or other manure. These trees, after they are planted out, will require no other pruning besides cutting off their bad branches, or such as cross each other.

ORDEAL, a form of trial for discovering innocence or guilt, formerly practised over almost all Europe, and which prevailed in England from the time of Edward the Confessor, till it was abolished by a declaration of Henry III. It was called *purgatio vulgaris*, or *judicium*, in opposition to *bellum*, or combat, the other form of purgation. In England, an offender, on being arraigned, and pleading not guilty, had it in his choice to put himself upon God and his country, that is, upon the verdict of the jury; or upon God alone, on which account it was called the judgment of God, it being presumed that God would deliver the innocent. The more popular kinds of ordeal were red-hot iron and water; the first for freemen and people of fashion, and the last for peasants. Fire ordeal was performed either by taking up in the hand a piece of red-hot iron, of one, two, or three pounds weight; or else by walking barefoot and blindfold over nine red-hot ploughshares, laid at unequal distances; and if the party escaped unhurt he was adjudged innocent; if not, he was condemned as guilty. Water ordeal was performed either by plunging the bare arm up to the elbow in boiling water, and escaping unhurt thereby; or by casting the person suspected, into a river or pond of water: if he floated therein, without any action of swimming, it was deemed an evidence of his guilt; but if he sunk, he was acquitted. 4 Black. 340.

**ORDER.** *See* Architecture.

**ORDER** of a Line, in the theory of Curves, denotes the dimension of the equation by which the line is expressed; it being of the 1st, 2d, 3d, &c. order, according as the equation is of the 1st, 2d, 3d, &c. degree or dimension.

**ORDERS**, or Ordination. No person shall be admitted to the holy order of deacon under 23 years of age; nor to the order of priest, unless he is 24 complete; and none shall be ordained without a title, that is, a nomination to some cure or benefice, and he shall have a testimonial of his good behaviour, for three years past, from three clergymen; and the bishop shall examine him, and, if he sees cause, may refuse him. And before he is ordained, he shall take the oath of allegiance and supremacy before the ordinary, and subscribe the thirty-nine articles.

**ORDINARY**, in common and canon law, is one who has an ordinary or immediate jurisdiction in ecclesiastical causes in such a place.

Ordinary *Seaman*, implies one who can make himself useful on board, but is not an expert or skilful sailor; the latter being termed an *able* seaman. Able seamen have consequently more wages than the ordinary.

*Ships in* Ordinary, are those which being laid up are under the direction of the master attendant.

**ORDINATE**, in the theory of Curves, any right line drawn from a point in the absciss to terminate in the curve; and if drawn perpendicularly to the absciss, it is called a *right ordinate.* It is a general property of the ordinates of a curve, that when perpendicular to the axis of a line of the second order, that is, in the circle and conic sections, the ordinates are all bisected by that axis, making the sum of all the ordinates on one side equal to that of those on the other; and in lines of the third order, where a line may cut the curve in three places, the ordinate on the one side is always equal to the sum of the ordinates on the other.

**ORDNANCE**, a general name for all sorts of great guns used in war.—See *Cannon*, and Plate *Oil Mill*, &c.

Ordnance, *Office of*, an office kept within the Tower of London, which superintends and disposes of all the arms, instruments, and utensils of war, both by sea and land, in all magazines, garrisons, and forts in Great Britain.

**ORES.** Metals, when found in a state of combination with other substances, have the name of *ores.* They are in general deposited in veins of various thickness, and at various depths in the earth. The mode of obtaining them is to penetrate from the surface of the earth to the vein, and there to follow it, in whatever direction it may lie. The hollow places thus formed are called *mines*, and the men employed in them are denominated *miners.* When the veins are at a great depth, or extend to any considerable distance beneath the surface of the earth, it is necessary at intervals to make openings or *shafts* to the surface, for the admission and circulation of the air; and also to draw off the water which collects at the bottom, by means of drains, pumps, or steam-engines, as the situation or circumstances require. After the metallic ores are drawn from the mine, they in general go through several processes before they are in a state fit for use. Some of them are first washed in a running water, to clear them from earthy particles. They are then piled together with combustible substances, and burnt or roasted, for the purpose of ridding them of the sulphur or arsenic with which they may happen to be combined, and which rises from them in a state of fume or smoke. Thus having been freed from impurities, they undergo the operation of melting, in furnaces constructed according to the nature of the respective metals, or the uses to which they are to be subsequently applied. *See* Metals.

**ORFFYREUS's** Wheel, in Mechanics, is a machine so called from its inventor, which he imagined to be a perpetual motion. This machine consisted of a large circular wheel or drum, twelve feet diameter, and fourteen inches in depth, and very light; it was formed of an assemblage of deals, the intervals between which were covered with waxed cloth, in order to conceal the interior parts of it. The two extremities of an iron axis, on which it turned, rested on two supports. On giving the wheel a slight impulse in either direction, its motion was gradually accelerated; so that after two or three revolutions, it required so great a velocity as to make twenty-five or twenty-six turns in a minute. This rapid motion it actually preserved during the space of two months, in the chamber of the landgrave of Hesse, the door of which was kept locked, and sealed with the landgrave's own seal. At the end of that time it was stopped, to prevent the wear of the materials. The professor, who had been an eye-witness to these circumstances, examined all the external parts of it, and was convinced that there could not be any communication between it and any neighbouring room. Orffyreus, however, was so incensed, that he broke the machine in pieces, and wrote on the wall, that it was the impertinent curiosity of professor Gravesande which made him take this step. The prince, who had seen the interior of this wheel, being asked whether, after it had been in motion some time, there was any change observable in it, and whether it contained any pieces that indicated fraud or deception, answered both questions in the negative, and declared, that the machine was of a very simple construction.

**ORGAN**, in general, an instrument or machine designed for the production of some certain action or operation; in which sense the mechanic powers, machines, and even the veins, arteries, nerves, muscles, and bones of the human body, may be called organs. The organs of sense are those parts of the body by which we receive the impressions or ideas of external objects, being commonly reckoned five, *viz.* the eye, ear, nose, palate, and cutis. *See* Mammalia, p. 613.

Organ, a wind instrument blown by bellows, and containing numerous pipes of various kinds and dimensions, and multifarious tones and powers. Of all musical instruments this is the most proper for the sacred purpose to which it is most generally applied, in all countries wherever it has been introduced. Its structure is lofty, elegant, and majestic; and its solemnity, grandeur, and rich volume of tone, have justly obtained it an acknowledged pre-eminence over every other instrument. The church organ consists of two parts; the main body, called the great organ, and the positive or little organ, which forms a buffet, commonly placed before the great organ. The size of an organ is generally expressed by the length of its largest pipe; thus they say, an organ of 8, 16, 32 feet, &c. The organ in the cathedral church at Ulm in Germany, is 93 feet high and 28 broad; its largest pipe is 13 inches diameter, and it has 16 pairs of bellows.

**ORGANIC** Remains. As it is fashionable to dignify various departments of knowledge and human speculation with Greek names, the researches of mankind respecting organic remains have received the pompous name *Oryctology.* Oryctology is then the science which teaches the natural history of those animal and vegetable substances which are dug out of the earth in a mineralized state. In the following slight sketch of the history of these substances it will be seen that the remarkable situations in which they have been found, and the extraordinary changes which they have undergone, have led to the adoption of various contradictory and absurd notions respecting their nature and origin; which have been corrected, as just ideas have been obtained respecting the formation of the earth itself. Xenophanes, more than 400 years before Christ, was led to the belief of the eternity of the universe, by discovering the remains of different marine animals imbedded in rocks and under the surface of the earth. Herodotus ascertained the existence of fossil shells in the mountains of Egypt, and was thereby induced to conclude that the sea must have once covered those parts. In the pyramids of Egypt, mentioned by this author, and which has been built at so early a period that no satisfactory accounts could be derived from tradition respecting their erection, the stones were found to contain the remains of marine animals, and particularly of such as exist no longer in a recent state, and differ essentially from all known animals. These were supposed by Strabo, who saw the fragments of these stones lying around the pyramids, to be the petrified remains of the lentils which had been used for food by the workmen. Eratosthenes, Xanthus of Lydia, and Strabo, have all noticed, and variously commented upon, the existence of animal remains thus wonderfully preserved. In the works of Pliny, many fossil bodies are mentioned; particularly the bucardia, resembling an ox's heart, but which was, doubtless, a cast formed in a bivalve shell; glossopetra, bearing the form of a tongue, and supposed to fall from the moon when in its wane; hammites, resembling the spawn of fish; horns of ammon, resembling in form the ram's horn; lepidotes, like the scales of fishes; meconites, bearing a resemblance to the seeds of poppies; brontia, to the head of a tortoise; spongites, to sponge; phycites, to sea-weeds or rushes.

The fossil remains of quadrupeds, especially those of the larger kind, are such as must necessarily excite the attention and wonder of every curious inquirer into natural history. In various parts of this country have been found the remains of elephants, and of other animals of considerable magnitude. In Ireland have been found the remains of deer, of a size far exceeding any now known; and in Scotland have been found the remains of the elk, as well as those of an enormous animal of the ox kind, but larger than even the urus. In France, Germany, and Italy, and indeed in most parts of Europe, remains of large animals have been found; and in both North and South America, the remains of enormous unknown animals have been discovered. According to Pallas, from the Tanais to the continental angle nearest to America, there is hardly a river in this immense space, especially in the plains, upon the shores or in the bed of which have not been found the bones of elephants and of other animals not of that climate. From the mountains by which Asia is bounded, to the frozen shores of the ocean, all Siberia is filled with prodigious bones; the best ivory (fossil) is found in the countries nearest to the arctic circle, as well as in the eastern countries, which are much colder than Europe under the same latitude; countries where only the surface of the ground becomes thawed during summer. The number of bones which have been discovered of the rhinoceros is very considerable, not only in Siberia, but in Germany, and in other parts of Europe; and in the opinion of St. Fond, founded not only on the discoveries of Pallas and others, but on his own observations made on the immense collection of Merck, joined with that of the landsgrave of Hesse Darmstadt, are of the species with double horns. An entire body of an animal of this species, still possessing the skin, fat, and muscles, has been dug up near the river Willioni, in the eastern part of Siberia, from under a hill which is covered with ice the greatest part of the year. St. Fond states, in confirmation of the above opinion, that another head obtained by Pallas from Siberia, one existing in the cabinet of the elector of Manheim, and another in the cabinet of Merck, are all apparently similar to the head of the double-horned rhinoceros of Africa.

Much remains to be ascertained with respect to the fossil remains of elephants, of which considerable numbers have been found in various parts of England, France, Germany, and Italy; but no where so abundantly as in Siberia. In America indeed the remains of enormous unknown species of this animal are also very abundant. There appears to be only two species of elephants now in existence: one (the Asiatic) being distinguished by its grinders being divided into transverse and nearly parallel plates, and the other (the African) having these plates disposed in lozenge-like forms. The elephantine remains which have been found in Siberia have been supposed to have belonged to no existing species; for though the teeth are formed of plates disposed parallel to each other, as in the Asiatic, these plates are said to be thinner, and consequently more numerous; but this distinction is by no means established. The remains of elephants discovered in this country, seem referrible, in most instances, to the Asiatic. The remains of an animal of an enormous size has been found at Paraguay, at no great distance from the river Plata, which being properly arranged, has been formed into a skeleton, and placed in a cabinet of natural history at Madrid. This animal, twelve feet in length and six in height, is distinguished as well by its general form as by the largeness of its claws.

In various parts of Scotland, and of France, in Tuscany, the Veronese, and in North America, have been found the fossil remains of some animal, which has been supposed to be a variety of the urus of Julius Cæsar, or of the bison. To the fossil remains already mentioned, may be added the animal incognitum of Symore in Languedoc; the enormous stag found in the mosses of Ireland; the gigantic tapir, found at the bottom of the black mountains of Languedoc; the bears, of two species now unknown, found in Bareith; and the numerous animals, of unknown species, which the admirably indefatigable Cuvier is perpetually discovering, in that mine of fossils, the quarries of gypsum near Paris. Of the mineral remains of man, no well-attested instance is known. In a cavern, indeed, in Mendip Hills, some human bones have been found invested with stalactite; these appear to be but comparatively of modern existence. Scheuchzer published an essay describing a supposed skeleton of a man; which was undoubtedly the remains of some large fish.

ORGANICAL DESCRIPTION OF CURVES, the method of describing them on a plane by means of instruments, as the compasses and ruler, which are the most simple, and are the only instruments admitted into plane or elementary geometry; but other instruments have been invented for the description of various curves, as elliptic compasses, conchoid, ellipse, hyperbola, parabola, &c.

ORGANZINE, in Commerce, a description of silk usually imported from Italy into this country. It is of the utmost importance to the manufacturer, as none of the principal articles could be fabricated without it; and the Italians, aware of this, long kept the art of throwing it a most profound secret. It was introduced into this country by the enterprise and skill of Messrs. Thomas and John Lombe.

ORIBASIA, a genus of plants belonging to the pentandria class, and in the natural method ranking under the 37th order stellatæ.

ORIENT, the east or eastern point of the horizon.—*Orient Equinoctial*, that point of the horizon where the sun rises when in the equinoctial.—*Orient Estival*, is that point of the horizon where the sun rises in the middle of summer.—*Orient Hybernal*, that point of the horizon where the sun rises in the middle of winter.

ORIENTAL, any thing or place situated to the eastward of an observer.

ORIGANUM, ORIGANY, or *Marjorum*, a genus of plants belonging to the didynamia class, and in the natural method ranking under the 42d order.

ORIGINAL, in the courts of King's Bench, the usual original writ issued in the actions, as for action of trespass upon the case. This court does not issue originals in actions of debt, covenant, or account, &c. whereas the Court of Common Pleas proceeds by original in all kinds of actions; but to arrest and sue a party to outlawry, it is used in both cases.

ORILLON, in Fortification, is a small rounding of earth, faced with a wall, raised on the shoulder of those bastions that have casemates, to cover the cannon in the retired flank, and prevent their being dismounted by the enemy.

ORIOLUS, ORIOLE, in Ornithology, a genus belonging to the order picæ. These birds are inhabitants of America, except in a few instances: they are a noisy and gregarious, frugivorous, granivorous, and voracious race, very numerous, and often have pensile nests. The several species, which are very numerous, since Latham describes no less than forty-five, seem to be principally distinguished by their colour.

ORION, the most brilliant constellation in the heavens, is highly embellished by several adjacent constellations of great splendour; and, when it comes to the meridian, there is then above the horizon the most splendid view of the celestial bodies that the starry firmament affords to the eye of the beholder; and this magnificent exhibition is visible to all the habitable world, because the equinoctial passes nearly through the middle of the constellation.—*Boundaries and Contents:* N. by Taurus; E. by Monoceros; S. by Lepus, and W. by Eridanus and Taurus. There are seventy-eight stars in this constellation, *viz.* two of the first magnitude, four of the second, four of the third, sixteen of the fourth, &c. Orion is a paratantellon of Taurus, and the brilliant Betelgeux, on his right shoulder, of the first magnitude, having 7° 21′ 54″ N. declination, and right ascension 86° 21′ 17″, appears in the Eastern horizon at London, on the E. by N. point of the compass, and rises and culminates for the first day of every month in the year, as in the following Table: Merid. Alt. 45° 50′ 54′.

| Month. | Rises. | Culm. | Month. | Rises. | Culm. |
|---|---|---|---|---|---|
| | ho. mi. | ho. mi. | | ho. mi. | ho. mi. |
| Jan. | 1 30 A | 10 57 A. | July | 1 27 M. | 11 2 M. |
| Feb. | 2 15 A. | 8 45 A. | Aug. | 2 25 M. | 8 58 M. |
| Mar. | 12 25 A. | 6 56 A. | Sept. | 12 25 M. | 6 58 M. |
| April | 10 26 M. | 5 3 A. | Oct. | 10 36 A. | 5 14 M. |
| May | 8 35 M. | 3 12 A. | Nov. | 8 55 A. | 3 18 M. |
| June | 6 25 M. | 1 10 A. | Dec. | 6 45 A. | 1 14 M. |

ORION'S *River*, another name for the constellation *Eridanus*.

ORLE, or ORLET, in Architecture, a fillet under the ovole or quarter-round of a capital; when it is at the top or bottom of a shaft, it is called cincture.

ORLOP, a platform of planks laid over the beams in the hold of a ship of war, whereon the cables are usually coiled. It also contains the sail-rooms, the purser's, surgeon's, boatswain's, and carpenter's cabins, and the several officers' store-rooms. In three-deck ships the second and lowest decks are sometimes called Orlops.

ORNITHOGALUM LATIFOLIUM and UMBELLATUM, are ornamental plants, and are often cultivated for their beautiful flower. The season for planting the bulbs is about the month of September.

ORNITHOGALLUM, *Star of Bethlehem*, a genus of plants belonging to the hexandria class, and in the natural method ranking under the 10th order, coronariæ.

ORNITHOLOGY, that branch of Zöology which treats of birds. *See* BIRD. Linnæus, whose ornithology we have followed, arranges the whole class of birds under six orders, according to the different figures of their beaks, *viz.* Accipitres, as eagles, vultures, and hawks; upper mandible with an angular projection. 2. Picæ, as crows, jackdaws, humming-birds, and parrots; bill compressed, with feet formed for perching and climbing. 3. Anseres, as geese, ducks, gulls, and swans; bill covered with skin, broad at the tip, some with and some without teeth. 4. Grallæ, as herons, woodcocks, and ostriches; bill roundish, tongue fleshy: some with three, some with four toes. 5. Gallinæ, as peacocks, pheasants, turkeys, and common fowls; bill convex, upper mandible arched. 6. Passeres, as sparrows, larks, and swallows; bills conic, and sharp-pointed. In this last order are comprehended pigeons.

ORNITHOPUS, a genus of plants belonging to the diadelphia class, and in the natural method ranking under the 32d order, papilionaceæ.

ORNITHORYNCHUS VEL PARADOXUS, the bird quadruped from New South Wales, a singular quadruped, which has not yet been properly classed in the Linnean system. The most remarkable circumstance, in this curious animal, is the great similarity of its head with that of a duck; the under part of the mandible having its margin indented, as in ducks; and the proper instrument for chewing being situated behind, within the cheeks.

ORNUS FRAXINUS, the ash which produces manna.

OROBANCHE, a genus of plants belonging to the didynamia class, and in the natural method ranking under the 40th order, personatæ.

OROBUS, *Bitter Vetch*, a genus of plants belonging to the diadelphia class, and in the natural method ranking under the 32d order, papilionaceæ.

ORONTIUM, a genus of plants belonging to the hexandria class, and in the natural method ranking under the second order, piperitæ.

ORPHAN. In the city of London there is a court of record established for the care and government of orphans.

ORPIMENT, is a mineral substance, of lemon-yellow colour, which consists of arsenic in combination with about forty-three parts of sulphur, and is about thrice as heavy as water. It is found both in a massive and crystallized state, in Natolia, Servia, Hungary, Turkey, and some other countries. In the latter state, the crystals are so confused, that their figures cannot easily be determined. The orpiment of commerce is an artificial production, and is chiefly imported from different parts of the Levant. The Turks and other Orientals use it in the depilatories which serve to render bald the top of the head. A very beautiful but fugitive pigment, called *king's yellow*, is prepared from this mineral, and other preparations of orpiment are occasionally used by painters, and also by dyers and calico-printers. The whole of these, however, are extremely poisonous.

ORRERY, an astronomical instrument for exhibiting the motions of the heavenly bodies, was first constructed by Graham, but its name is derived from one made by Rowley for the Earl of Orrery, which was supposed by Sir R. Steel to be the first ever constructed; and he therefore gave it the above name in honour of the Earl, and attributes the invention to Mr. Rowley; whose name it has ever since retained, though the error on which it was adopted has long been corrected.

ORRIS-ROOT, is the root of a white-flowered kind of iris, called *Florentine Iris*, which is a native of Italy, and is distinguished by having two flowers on each stalk; the petals bearded, and the leaves sword-shaped. In a dried state, this root is well known on account of its grateful odour, which somewhat approaches that of the violet. It is consequently much used in the manufacture of hair powder, and other articles for which an agreeable scent is required. It is sometimes employed in medicine as a pectoral or expectorant, and sometimes in dropsies. In a recent state the root is extremely acrid; and, when chewed, excites in the mouth a pungent taste, which continues for several hours; but this acrimony is almost wholly dissipated by drying. Orris-root is chiefly imported into this country from Leghorn.

ORTHODROMICS, in Navigation, is the same as Great Circle Sailing, and indicates the straight or shortest distance, which can only be in the arc of a great circle.

ORTHOGRAPHIC PROJECTION OF THE SPHERE, is that projection which is made upon a plane passing through the middle of the sphere, by an eye placed vertically at an infinite distance.

ORTHOGRAPHY, that part of grammar which teaches the nature and affections of letters, and the just method of spelling or writing.

ORTHOGRAPHY, in Geometry, the art of drawing or delineating the fore-right plan of any object, and of expressing the heights or elevations of each part. It is called orthography, from its determining things by perpendicular lines falling on the geometrical plane.

ORTHOGRAPHY, in Architecture, the elevation of a building.

ORTHOGRAPHY. *See* PERSPECTIVE.

ORTIVE, or EASTERN AMPLITUDE, in Astronomy, is an arch of the horizon intercepted between the place where a star rises and the east point of the horizon.

ORTOLAN. *See* EMBERIZA.

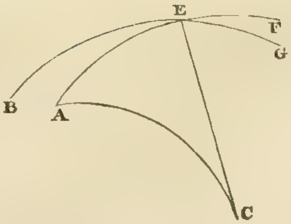
ORYZA, RICE, a genus of the dyginia order, in the hexandria class of plants; and in the natural method ranking under the 4th order, gramina. There is but one species, namely, the sativa or common rice. This plant is greatly cultivated in most of the Eastern countries, where it is the chief support of the inhabitants; and great quantities of it are brought into England and other European countries every year, where it is much esteemed for puddings, &c. it being too tender to be produced in these northern countries without the assistance of artificial heat: but from some seeds which were formerly sent to Carolina, there have been great quantities produced, and it is found to succeed there as well as in the Eastern countries. It has been cultivated with advantage in Lombardy in Italy; but the stagnant water in which it grows being injurious to health, the government does not permit the extension of the cultivation to new lands.

OSCILLATION, in Mechanics, vibration, or the reciprocal ascent and descent of a pendulum.

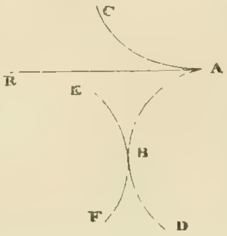
*Axis* of OSCILLATION, is a right line passing through the point of suspension parallel to the horizon.

*Centre* of OSCILLATION, is that point in a vibrating body into which, if all the matter of the body were collected, the vibrations would be performed in the same time.

OSCULATION in the theory of Curves, denotes the contact between any curve and its osculatory circle; or that circle which has the same curvature as the curve at the given point of



osculation. If A C be the evolute of the involute curve A E F, and the tangent C E the radius of curvature at the point E, with which and the centre C, if the circle B E G be described, this circle is said to osculate or kiss the curve A E F, in the point E; which point E is called the point of osculation; C E the osculatory radius, or radius of curvature: the circle B E G the osculatory circle; and the evolute A C the locus of all the centres of the osculatory circles.



Point of osculation is also used to denote the concourse of two branches of a curve that touch each other; which differs from a cusp or point of retrocession, in this, that in the latter case, although it forms a point of concourse, the curve terminates there; whereas in a point of osculation, the curve does not terminate, but is continued on both sides. Thus, in the annexed figure, A is a point of retrocession, and B a point of osculation.

**OSCULATORY** Circle, or Kissing Circle, is the same as the circle of curvature; such is the circle B E G in the preceding figure, article Osculation.

**OSIER**, a very valuable shrub, of the salix viminales, used principally in basket-making.

**OSMIUM**. A new metal lately discovered by Mr. Tenant among platina, and thus called by him from the pungent and peculiar smell of its oxide. Pure metal, previously heated, did not appear to be acted upon by acids. Heated in a silver cup with caustic alkali, it combined with it, and gave a yellow solution similar to that from which it was procured. From this solution acids separate the oxide of osmium.

**OSMUNDA**, *Moonwort*, a genus of plants belonging to the cryptogamia class.

**OSSIFICATION**. The deposition of the phosphate and carbonate of lime on the soft solids of animal bodies, as, on the lungs, liver, heart, &c.

**OSTENSIVE** Demonstration, is a direct geometrical demonstration, in contradistinction to an apogogical one, or that which depends upon a *reductio ad absurdum*.

**OSTRACTION**, *Trunk-fish*, a genus of fishes, of the order nantes; the generic character is, teeth pointing forwards, cylindric, rather blunt; body mailed by a bony covering.

**OSTREA**, the *Oyster*, in Zöology, a genus belonging to the order of vermes testacea. There are thirty-one species, principally distinguished by peculiarities in their shells. The common oyster is reckoned an excellent food, and is eaten both raw and variously prepared. The oyster differs from the muscle in being utterly unable to change its situation. It is entirely without a tongue, which answers the purposes of an arm in the other animal, but nevertheless is often attached very firmly to any object it happens to approach. Oysters usually cast their spawn in May, which at first appears like drops of candle-grease, and sticks to any hard substance it falls upon. These are covered with a shell in two or three days; and in three years the animal is large enough to be brought to market. As they invariably remain in the places where they are laid, and as they grow without any other seeming food than the afflux of sea-water, it is the custom at Colchester, and other parts of England, where the tide settles in marshes on land, to pick up great quantities of small oysters along the shore, which, when first gathered, seldom exceed the size of sixpence. These are deposited in beds where the tide comes in, and in two or three years grow to a tolerable size. They are said to be better tasted for being thus sheltered from the agitations of the deep; and a mixture of fresh water entering into these repositories, is said to improve their flavour and increase their growth and fatness. The oysters, however, which are prepared in this manner, are by no means so large as those found sticking to rocks at the bottom of the sea, usually called rock-oysters. These are sometimes found as broad as a plate, and are admired by some as excellent food. But what is the size of these compared to the oysters of the East Indies, some of whose shells have been seen two feet over? The oysters found along the coast of Coromandel, are capable of furnishing a plentiful meal for eight or ten men; but it seems universally agreed that they are no way comparable to ours for delicacy of flavour.

**OTACOUSTIC**, a name sometimes given to a hearing trumpet and other instruments for improving the sense of hearing.

**OTIS**, the *Bustard*, in Natural History, a genus of birds of the order gallina. Gmelin mentions eleven species, and Latham nine. We shall notice only the following:—The great bustard, found in the plains of Europe, Asia, and Africa, but has never been observed in the New Continent. In England it is occasionally met with on Salisbury Plain, and in the wolds of Yorkshire, and formerly was not uncommonly seen in flocks of forty or fifty. It is the largest of British land birds, weighing often twenty-five or thirty pounds. It runs with great rapidity, so as to escape the pursuit of common dogs, but falls speedily a victim to the greyhound, which often overtakes it before it has power to commence its flight, the preparation for which, in this bird, is slow and laborious. The female lays her eggs on the bare ground, never more than two in number, in a hole scratched by her for the purpose; and if these are touched or soiled during her occasional absence, she immediately abandons them. The male is distinguished by a large pouch, beginning under the tongue, and reaching to the breast, capable of holding, according to Linnæus, seven quarts of water. This is sometimes useful to the female during incubation, and to the young before they quit their nest; and it has been observed to be eminently advantageous to the male bird himself, who on being attacked by birds of prey, has often discomfited his enemies by the sudden and violent discharge of water upon them. These birds are solitary and shy, and feed principally upon grasses, worms, and grain. They were formerly much hunted with dogs, and considered as supplying no uninteresting diversion. They swallow stones, pieces of metal, and other hard substances. Buffon states that one was opened by the academicians of France, which contained in its stomach ninety doubloons, and various stones, all highly smoothed by the attrition of the stomach. The little bustard is met with in many parts of Europe, particularly in France, where it is taken by nets. It is rarely seen in England, is shy and cunning; if molested, will fly about two hundred paces, and then run so fast that a man cannot overtake it. Its flesh is like that of the great bustard, rich and delicate, and it would appear worth while to attempt the domestication of both these birds.

**OTTER**. *See* Mustela.

**OUNCE**, a little weight, the sixteenth part of a pound avoirdupois, and the twelfth part of a pound troy; the ounce avoirdupois, is divided into eight drachms, and the ounce troy into twenty pennyweights.

Ounce. *See* Felis.

**OUTFIT**, implies the expenses of equipping a ship out for sea.

**OUT** of Trim, the state of a ship when she is not properly balanced for the purposes of navigation, which may be occasioned by a defect in the rigging, or in the stowage of the hold.

**OUTLAWRY**, the punishment of a person who being called into law, and lawfully sought, according to the usual forms, does contemptuously refuse to appear. The effect of being outlawed at the suit of another, in a civil case, is the forfeiture of all the outlaw's goods and chattels to the king, and the profits of his lands while the outlawry is in force.

**OUTLICKER**, a small piece of timber made fast to the top of the poop, and standing out right astern.

**OUTRIGGER**, a strong beam of timber, of which there are several, fixed on the side of a ship, and projecting from it, in order to secure the masts in the act of careening, by counteracting the strain it suffers from the effort of the careening tackles, which being applied to the mast head, draw it downwards, so as to act upon the vessel with the power of a lever, whose fulcrum is in her centre of gravity.

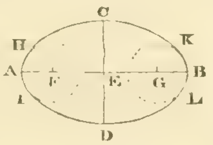
Outrigger, is also a small boom, occasionally used in the tops, to thrust out the breast backstays to windward, in order to increase the angle of tension, and thereby give an additional security to the topmast. It is usually furnished with a tackle at its inner end, communicating with one of the topmast shrouds, and has a notch on the outer end to contain the backstay, and keep it steady therein. As soon as the backstay is drawn tight by means of its tackles in the chains, the outrigger is applied aloft, which it forces out to windward, beyond the circle of the top, so as to increase the angle which the mast makes with the backstay, and accordingly enables the latter the better to support the former. This machine is sometimes applied without any tackle; it is then thrust out to its usual distance beyond the top rim, wherein it is securely fastened; after which, the backstay is placed in the notch, and extended below.

**OUTWARD**, in Navigation, implies out of the port, or kingdom, as, "the outward-bound ships, as by my last letter."

**OUTWORKS**, in Fortification, all those works made without-side the ditch of a fortified place, to cover and defend it. Outworks, called also advanced and detached works, are those which not only serve to cover the body of the place, but also to keep the enemy at a distance, and prevent his taking advantage of the cavities and elevations usually found in the places about the counterscarp, which might serve them either as lodgments, or as rideaux, to facilitate the carrying on their trenches, and planting their batteries against the place; such are ravelines, tenailles, horn-works, velopes, crown-works, &c.

**OVAL**, an oblong curvilinear figure, having two unequal diameters, and bounded by a curve line returning into itself. Under this general definition of an oval is included the ellipse, which is a regular oval; and all other figures which resemble the ellipse, though without possessing its properties, are classed under the same general denomination.

We have shewn under the article Ellipse, different mechanical methods of describing ellipses; and we shall therefore only give in this place a practical method of describing an oval, which to the eye very much resembles the conical ellipse; this is as follows;—Set the given length A B at right angles to the breadth C D, so that they bisect each other perpendicularly at E; with the centre C and radius A E describe an arc to cross A B, in F and G, and with the radii A F and B G, describe two little arcs, and H I and K L for the smaller ends of the oval; and then with centres C and D, and radius C D, describe the arcs H C K and I D L, for the flatter or larger arcs of the figure.



**OVERBLOW**, is when the wind blows so very hard that the ship can bear no top-sails.

**OVERBOARD**, the state of being thrown out, or the act of falling from a ship or boat into the water on which she swims; as, there is a man overboard,—he threw her guns overboard, &c.

Overcast *Staff*, a scale or measure, employed by shipwrights to determine the difference between the curves of those timbers, which are placed near the greatest breadth, and those which are situated near the extremities of the keel, where the floor rises and grows narrower.

**OVERGROWN**, is said of the sea when the surges and billows are unusually high; but when the waves are no more than commonly high, it is called a rough sea.

**OVERHAULING**, the act of opening and extending the several parts of a tackle or other assemblage of ropes, communicating with blocks or dead-eyes, so that they may be again placed in a state of action.

Overhauling, also implies an examination of a ship, person, or thing. One ship is said to overhaul another, when she gains fast upon her in chace.

**OVERMASTED**, the state of a ship whose masts are too high, or too heavy, for the weight of her keel to counterbalance.

**OVERRAKE**, when a ship rides at anchor in a head sea, the waves of which frequently break in upon her, they are said to overtake her.

**OVERSEERS** of the Poor. By 43 Elizabeth, c. 2, § 1, the churchwardens of every parish, or two substantial householders, to be nominated yearly within fourteen days after the 25th of March, under the hand and seal of two justices of the peace of the county, shall be overseers of the same parish. In general, all persons are liable to serve, with some exceptions as to peers of the realm, clergymen, parliament men, attorneys, practising barristers, the president and members of the college of physicians, surgeons, and apothecaries free of the hall; dissenting ministers, prosecutors of felons having a Tyburn ticket, and soldiers actually serving in the militia. In extensive parishes, a great number of overseers are appointed under 13 and 14 Charles II. c. 12. § 21; and by 17 George II. c. 38, if an overseer dies, removes, or becomes insolvent, the justices may appoint another, and their appointment is subject to appeal to the sessions By 43 Elizabeth, c. 2, § 2, overseers shall within fourteen days after the appointment of new ones, deliver to them an account to be allowed by two justices, and pay over balances due from them, which, if not paid, may be levied by distress, and the party committed to prison by the justices until the balance is paid, and the account delivered in; and by 17 George II. c. 38, the account is to be verified by oath. If he removes, the overseer is to account in like manner. If he dies, his executors have forty days to account, and must pay the balance before any other debts. Their duty consists in raising the poor's-rates, taking care of the poor, giving relief to casual poor, and removing improper persons who have become actually chargeable and have no legal settlement. They are also to bind out the children of poor persons, and in that case the infant parish apprentice and his master cannot vacate the indentures without the overseers. They are also to procure orders of maintenance of bastards to be made, and bonds to be taken from the reputed father to indemnify the parish. It has been usual for overseers in those cases, instead of taking a bond of indemnity, to accept of a sum of money, and discharge the father. But this has been lately held to be illegal, because it gives the overseers an interest to procure the death of the child. In cases of removal also, overseers should be careful not to execute the order in a harsh and improper manner, for if a person die in consequence of a removal at a time of sickness, the overseer may be guilty of murder, and liable to an indictment. Overseers also should not improperly conspire to force persons who are with child of bastards, to marry and relieve the parish, for this also is indictable. By 17 George II. c. 38, if any person shall be aggrieved by any thing done or omitted by the churchwardens and overseers, or by any of his majesty's justices of the peace, he may, giving reasonable notice to the churchwardens or overseers, appeal to the next general or quarter sessions, where the same shall be heard, or finally determined; but if reasonable notice be not given, then they shall adjourn the appeal to the next quarter sessions; and the court may award reasonable costs to either party, as they may do by 8th and 9th William, in case of appeals concerning settlements. *See* Poor. By 43 Elizabeth, c. 2, § 2, they forfeit 20*s.* on neglecting to meet in the vestry one Sunday in the month; and by 13 and 14 Charles II. c. 4, forfeit £5 for refusing relief to a person duly removed by warrant of two justices. By 9 George III. c. 37, § 7, they are to forfeit 10*s.* or 20*s.* for paying the poor in bad money.

**OVERSETTING**, the act of turning any thing upside down: also the movement of a ship when her keel turns upwards; which misfortune happens either by bearing too much sail, or by grounding her so that she falls on one side.

**OVERT**, the same with open. Thus an overt act signifies an act which, in law, must be clearly proved; and such as is to be alleged in every indictment for high treason.

**OVIS**, *Sheep*, a genus of the order pecora, usually the most timid of quadrupeds. When sheep, however, have an extensive range of pasture, and are left in a considerable degree to depend upon themselves for food and protection, they exhibit more respectability of character. A ram has been seen in these circumstances to attack and beat off a large and formidable dog, and even a bull has been felled by a stroke received between his eyes, as he was lowering his head to receive his adversary on his horns, and toss him into the air. When individual efforts are unequal to the danger, sheep will unite their exertions, placing the females and their young in the middle of an irregular square; the rams will station themselves so as to present an armed front on every side to the enemy, and will support their ranks in the crisis of attack, harassing the foe by the most formidable and sometimes fatal blows. Sheep display considerable sagacity in the selection of their food, and in the approach of storms they perceive the indications with accurate precision, and retire for shelter always to the spot which is best able to afford it. The domestic sheep is scarcely ever found (excepting in temperate latitudes) in a state approaching to perfection. In hot regions its wool degenerates into a species of hair, and in rigid climates, though the wool is fine at the root, it is coarse towards the surface.

**OWNER**, the proprietor of any thing, as of a ship, by whom she is freighted to the merchant for a sea voyage.

**OX**, in Zöology, is a generic term, synonymous with Bos, including both the male and female. Few species, however, of this tribe appear to be really distinct. Their variations arise from climate, domestication, and other causes, which it would be tedious to enumerate. In modern language, the word ox is confined to the male species of neat cattle that have undergone mutilation by the hands of man. In this sense, the animal is too well known to require any particular description, either of its natural history, its formation, or its utility.

**OXALATES.** Compounds of salifiable bases with the oxalic acid.

**OXALIC ACID.** This acid, which abounds in wood sorrel, and which, combined with a small portion of potash, as it exists in that plant, has been sold under the name of salt of lemon, to be used as substitute for the juice of that fruit, particularly for discharging ink spots and iron-moulds, was long supposed to be analogous to that of tartar. The oxalic acid is a good test for detecting lime, which it separates from all the other acids, unless they are present in excess. It has likewise a greater affinity for lime than for any other of the bases, and forms with it a pulverulent insoluble salt, not decomposable except by fire, and turning syrup of violets green. Oxalic acid acts as a violent poison when swallowed in the quantity of two or three drachms; and several fatal accidents have lately occurred, in consequence of its being improperly sold instead of Epsom salts. The immediate rejection from the stomach of this acid, by an emetic, aided by copious draughts of warm water containing bicarbonate of potash, or soda, or chalk, or carbonate of magnesia, are the proper remedies. The stomach pump has of late been successfully used in discharging this poison. *See* SYRINGE.

**OX-EYE**, a small cloud or meteor, seen at the Cape of Good Hope, which presages a dreadful storm. It appears at first in the form or size of an ox's eye, but descends with such celerity, that it seems suddenly to overspread the whole hemisphere, and at the same time forces the air with such violence that ships are sometimes scattered several ways, some directly contrary, and many sunk downright.

**OXGANG**, or OXGATE, is generally taken, in our old law books, for fifteen acres, or as much ground as a single ox can plough in a year.

**OXIDATION.** The process of converting metals, or other substances, into oxides, by combining with them a certain portion of oxygen. It differs from acidification, in the addition of oxygen not being sufficient to form an acid with the substance oxided.

**OXIDE**, CARBONIC. When a mixture of purified charcoal and oxide of iron or zinc is exposed to a strong heat in an iron retort, the metallic oxide is gradually reduced, and, during the reduction a great quantity of gas is evolved. This gas is a mixture of carbonic acid gas, and another which burns with a blue flame. This last is carbonic oxide.

**OXIDES.** Substances combined with oxygen, without being in the state of acid.

**OXYDE**, or OXIDE, a chemical term denoting a very numerous class of bodies, formed by the union of certain bases, with a smaller proportion of oxygen than what is necessary for their conversion into acids. Metals oxydize by combustion, solution in acids, and exposure to the air, rain, &c. as in the case of rust of iron, which is an oxide.

**OXYGEN**, is a constituent part of the atmospheric air, of water, of acids, and of all bodies of the animal and vegetable kingdoms; combined with light and heat, and as oxygen gas, it approaches nearest to purity. Oxygen is only known in combination with other bodies and has not been obtained alone. When absorbed by combustible bodies, it converts them into acids. It is necessary to combustion, uniting itself always to bodies which burn, augmenting their weight, and changing their properties. It is necessary also to the respiration of animals. To procure oxygen gas, a quantity of manganese is produced into a glass retort, furnished with a ground stopper; a quantity of oil of vitriol (sulphuric acid,) sufficient to moisten the manganese, is added, and they are mixed together by means of a glass rod; the bottom of the retort is then gently heated by means of a lamp, and the extremity of its neck introduced under an inverted cylinder, filled with water in the hydro-pneumatic apparatus. Globules of gas will soon rise through the water; the first portions collected must be thrown away, being principally the common air contained in the retort; when a quantity equal to the capacity of the retort has been thus disposed of, the remainder may be preserved for use. There are many other modes of obtaining oxygen gas; the same manganese, heated to redness in an iron tube, such as a gun-barrel, the touch-hole of which is closed, will afford a considerable quantity of the substance, which may be collected by means of a tube fastened into the neck of the barrel, and having its extremity in the hydro-pneumatic apparatus. Nitre heated strongly in a porcelain retort, gives off oxygen gas; puce-coloured or red oxide of lead offers a similar result; and from any of the salts called hyper-oxymuriates, oxygen is procured by a dull red heat; a retort of glass may be employed in the process; and a charcoal fire in a small chafing-dish. One hundred grains of the hyper-oxymuriate of potassa, afford about one hundred and fourteen cubical inches of oxygen gas, under common circumstances. Oxygen gas may be procured in the hydro-pneumatic apparatus from zinc or iron filings, by means of oil of vitriol diluted with eight times its weight of water; a retort, or a bottle furnished with a tube, may be used; no artificial heat is required in the process. It may likewise be produced by passing steam over turnings of iron heated to redness in a gun-barrel. Oxygen gas, combined with hydrogen, forms water; with nitrogen, common atmospheric air; with sulphur, phosphorus, &c. sulphuric acid, phosphoric acid, &c.; alone it has neither smell nor taste. Oxygen gives the sharp, acrid character to those which are called acids. It combines with metals, destroys their metallic lustre, and gives them an earthy or *rusty* appearance. These substances are called oxides, and they are all heavier than the metals from which they are formed. Oxygen readily enters into combination, and no substance is more active as a chemical agent. It is known to be a constituent part of most of the acids and earths, and of all the alkalies except one, and the history of its compounds forms the most extensive and important part of modern chemistry. The operations of oxygen are connected with many of the arts; with the processes of bleaching, dying, colour-making, and metallurgy; and in its various applications to the production of fire, it is absolutely essential to cultivation, and to the comforts and enjoyments of social life.

**OXYMEL.** A compound of honey and vinegar.

**OXYMURIATES.** Compounds of the chloric acid with salifiable bases. The oxymuriate of mercury is corrosive sublimate. The oxymuriate or chloride of alumina has been used in discharging Turkey red.

**OXYMURIATIC ACID GAS.** *See* CHLORINE.

**OYER** OF DEED, is when a man brings an action upon a deed, bond, &c. and the defendant appears, and prays that he may hear the bond, &c. wherewith he is charged, and the same shall be allowed him; and he is not bound to plead till he has it, paying for the copy of it. The time allowed for the plaintiff to give oyer of a deed, &c. to the defendant, is two days exclusive after it is demanded. Carth. 454. 9 Durnf. and East. 40.

**OYER AND TERMINER**, is a court held by virtue of the king's commission to hear and determine all treasons, felonies, and misdemeanors. This commission is usually directed to two of the judges of the circuit, and several gentlemen of the county; but the judges only are of the quorum, so that the rest cannot act without them. 4 Black. 269. *See* ASSIZES.

**O YES**, corrupted from the French *oyez*, hear ye; is an expression used by the crier of a court, in order to enjoin silence when any proclamation is made.

# P.

P, as an abbreviation, among Astronomers, stands for *post*, after; as P. M. *post meridian*, *i. e.* after 12 at noon. P, with physicians, signifies *pugil*, a handful, or *pulvis*, powder.

PABULUM of PLANTS. No one principle affords the pabulum of vegetable life; it is neither charcoal, nor hydrogen, nor azote, nor oxygen, alone; but all of them together, in various states and combinations.

PACE, two and a half feet; but the geometrical pace is 5 feet, and 60,000 such paces make one degree of the equator.

PACE, in the Manege, is of three kinds, the walk, trot, or gallop.

PACK, in Commerce, is a horse's load; as, a pack of wool, which is 17 stone 2lbs. Hence from pack, we have—

PACKAGE, the duty of one penny in the pound paid for all goods not particularly rated.

PACKERS, persons whose employment it is to pack up all goods intended for exportation; which they do for the great trading companies and merchants of London, and are answerable if the goods receive any damage through bad package.

PACKET BOAT, a vessel appointed by government to carry the mail of letters, packets, and expresses, from one part of the kingdom to another by sea, or to the colonies, in the most expeditious manner. This service is now very expeditiously executed by the *steam packets*.

PACOS. *See* CAMELUS.

PADDOCK COURSE, a piece of ground with pales or a wall, and taken out of a park for exhibiting races with greyhounds, for plates, wagers, and the like. This area is generally a mile in length and a quarter of a mile broad.

PADDOCK, in Agriculture, signifies nothing more than a small field or enclosure. It is also a name given to a large toad or frog.

PÆDEROTA, a genus of plants, of the pentandria class; and in the natural method ranking with the 30th order, contortæ.

PÆONIA, PIONY, a genus of plants belonging to the polyandria class; and in the natural method ranking under the 26th order, multisiliquæ.

PAGAN, from the Latin *pagus*, a villager, not a citizen.

PAGAN, BLAISE FRANCOIS COMTE DE, a very eminent French mathematician and engineer, was born at Avignon in Provence, in 1604, and died in 1665, in the sixty-first year of his age. Pagan was most distinguished in his military character, and for the works which he wrote on the theory of fortification; but his other performances are also very honourable testimonies of his scientific acquirements.

PAGANISM, the religion of the heathen nations, in which the Deity is represented under various forms, and by all kinds of images, or idols; it is therefore called idolatry, or image worship. The theology of the pagans was of three sorts, *viz.* fabulous, natural, and political or civil. The first treats of the genealogy, worship, and attributes of their deities; who were for the most part the offspring of the imagination of poets, painters, and statuaries. To their gods were given different attributes, ascribing to them every species of vice, as well as to some of them every virtue.

PAGE, a youth of state, retained in the family of a prince or great personage, as an honourable servant to attend in visits of ceremony, carry messages, bear up trains, robes, &c. and at the same time to have a genteel education, and learn his exercises.

PAGOD, or PAGODA, a name whereby the East Indians call the temple in which they worship their gods. The pagod usually consists of three parts; the first is a vaulted roof, supported on stone or marble columns: it is adorned with images; and being open, all persons without distinction are allowed to enter it. The second part is filled with grotesque and monstrous figures, and no person is allowed to enter it but the bramins themselves. The third is a kind of chancel, in which the statue of the deity is placed. It is shut up with a very strong gate.

PAGOD, or *Pagoda*, is also the name of a gold or silver coin, current in several parts of the East Indies, value 5*s*

PAIN, an uneasy sensation, arising from a sudden and violent solution of continuity, or other accident, in the nerves, membranes, vessels, &c. From the sense of feeling, as well as all the other senses, either pain or pleasure may arise; nay, to this sense we commonly refer both pain and almost all other troublesome sensations, though in truth pain may arise from every vehement sensation. It is brought on by any great force applied to the sentient part; whether this force comes from within or from without. Whatever therefore pricks, cuts, lacerates, distends, compresses, bruises, strikes, gnaws, burns, or in any manner of way stimulates, may create pain. Hence it is so frequently conjoined with so many diseases, and is often more intolerable than even the disease itself. A moderate degree of pain stimulates the affected part, and by degrees the whole body; produces a great flux of blood to the part affected, by increasing the action of its vessels; and it seems also to increase the sensibility of the part affected to future impressions. It often stimulates to such motions as are both necessary and healthful. Hence, pain is sometimes to be reckoned among those things which guard our life. When very violent, however, it produces too great irritation, inflammation, and its consequences, fever, and all those evils which flow from too great force of the circulation; it disorders the whole nervous system, and produces spasms, watching, convulsions, delirium, debility, and fainting. Neither the mind nor body can long bear very vehement pain; and indeed nature has appointed certain limits, beyond which she will not permit pain to be carried, without bringing on delirium, convulsions, syncope, or even death, to rescue the miserable sufferer from his torment. Long continued pain, even though in a more gentle degree, often brings on debility, torpor, palsy, and rigidity of the affected part. But if not too violent, nor accompanied with fever, sickness, or anxiety, it sometimes seems to contribute to the clearness and acuteness of the judgment, as some people testify who have been afflicted with the gout.

PAINTING, is the art of representing all objects of nature visibly, by lines and colours, on a plain surface; and may be divided into Invention, Composition, Design, and Colouring. *See* DRAWING.

Invention consists generally in the choice of such subjects as are best calculated to answer some great and interesting end.—Composition regards the arrangement of the subject both as to forms, and to the general effects of light and shade, and of colour.—The important objects which Design embraces, will be found under that article. *See* DESIGN.

Colouring regards first, the infinite variety of hues with which nature distinguishes her forms, agreeably to the degree and mixture of the rays of light which their surfaces reflect; and secondly, the distribution, apposition, and accompaniment, of various hues or tints, to produce the effect most pleasing to the sight, a circumstance in which nature does not always delight.

*Colouring.*—It is the duty of the colourist to consider, that as there are two sorts of objects, the natural or real, and the artificial or painted; so there are also two sorts of colours, *viz.* the natural, or that which makes all the objects in nature visible to us; and the artificial, or that which, by a judicious mixture of simple colours, imitates those natural ones in all their various situations and circumstances. Several colours which, placed unmixed by one another, have a kind of aerial brightness, when mixed together produce a disagreeable earthy colour; for instance, ultramarine with fine yellow, or fine vermilion. Colours, which by mixture lose strength and become harmonious, are called broken colours, and contribute as greatly to the sweetness and softness of tones in pictures, as they subtract from their brightness.

*Chiaro Scuro.*—The art of chiaro-scuro consists, 1st. In connecting and combining the figure or objects of a composition in such masses of light and of shade as are both the most pleasing to the eye, and best calculated for the just development and display of the subject. 2d. In assigning to each object the colour most corresponding (on account of the force or qualities above mentioned) to its respective place in the general mass or group, and at the same time best harmonizing with the other colours of the picture, either by its natural and proper tone, or by the reflected hues which it receives from adjoining or surrounding objects. The beauty of these reflexes depends on the skilful adaptation of transparent or opaque colours. 3d. In the judicious introduction of such accidents as contribute to strengthen the general effect and character of the work.

*Composition.*—Composition may be divided into the general distribution of objects, the grouping, the choice of attitudes, the contrast, the cast of draperies, and the management of the back ground, or the connexion of the whole effect. In composition, as far as regards the general distribution of objects, the painter ought to contrive, that the spectator may, at the first sight, be struck with the general character of the subject, or at least may comprehend its principal scope. This effect is most readily produced, by placing the most essential figures in the most conspicuous places, provided it can be done without violence or impropriety. Besides this distinctness in the general expression of the subject, the beauty of the composition will depend on the variety, connexion, and contrast, displayed in the distribution of objects; provided, in like manner, that these are conformable to the nature of the subject, whether gay, familiar, full of motion and hurry, or still, solemn, and melancholy. The grouping regards both design and chiaroscuro. In the former, it respects the figures principally concerned in the expression of the subject, which must necessarily be near to or distant from one another, as their actions, conversations, or other mutual relations, require. In the latter, it regards those masses which are formed from objects which may be properly arranged together, and those effects of light and shade which are formed in consequence of such assemblage or union. These are the points to which the attention must be principally and diligently directed in forming the groups of a composition. The choice of attitude is the principal subordinate division of grouping. Whatever attitude is given, it must not only contribute its due portion to the completion of the group, but the greatest care must be taken by the painter, that it does not appear to be introduced for that purpose merely. It must be appropriate to the character of the individual figure, and expressive of its requisite action; and it must at the same time combine whatever beauty of form can be shewn by such a selection of turns or views of the body, as the necessary circumstances will admit. The knowledge of generic characters, under the various modifications of sex, age, and condition; of the various operations of the passions in the human mind; and a thorough acquaintance with the circumstances of the history, or other subjects to be represented, are the best guides to a good choice of attitudes.

*Of the different Classes of Painting.*—Painting is chiefly divided into historical, (comprehending allegorical and mystical,) grotesque, portrait, fancy, animals, fruits and flowers, battles, landscape, sea views, architecture, and still life. The subordinate divisions of all these are endless. Grotesque paintings are to be found in the celebrated Loggia of the Vatican palace at Rome, painted from the designs of Raffaelle, and in the ceiling of the portico of the Capitol, carved from those of Michael Angelo. Of portrait, as being a branch of painting to which our country is peculiarly addicted, it is requisite to give a more detailed account.

*Portraiture.*—The greatest perfection of a portrait is extreme likeness, and the greatest fault is the resemblance of a person for whom it was not designed, unless we are inclined to except a still more grievous defect, *viz.* the want of resemblance to any person whatever.

The different modes of painting now in use are:—Oil painting; preferable to all other methods, as it admits of a perfect gradation of the tints in the most durable of all materials, except those of Mosaic painting. Fresco painting; which is performed with colours diluted in water, and laid on a wall newly plastered, with which they incorporate, and are sometimes as durable as the stucco itself. Crayon painting; in which colours, either simple or compound, are ground in water mixed with gum, and made into small rolls of a hard paste, which are then used on paper or parchment. Miniature painting; which consists of colours prepared with water or gum, and laid on vellum or ivory. Enamel painting; which is performed on copper or gold, with mineral colours, dried by fire. This method is also very durable. Wax, or encaustic painting; performed by the mixture of wax with the varnish and colours. Painting on glass, too well known to need description, and performed by various methods. Painting in distemper; which is with colours mixed with size, white of eggs, or any thin glutinous substance, and used on paper, linen, silk, board, or wall. Painting in water colours, more properly called limning: it is performed with colours mixed with water, gum, size, paste, &c. on paper, silk, and various materials. To these is to be added elydoric painting, consisting of a mixed use of oil colours and waters.

*Method of Painting in Fresco.*—Before you begin to paint, it is necessary to apply two layers of stucco on the place where your work is to be executed. If you are to paint on a wall of brick, the first layer is easily applied; if of freestone closely joined, it is necessary to make excavations in the stone, and to drive in nails or pegs of wood, in order to hold the layer together. The first layer is made of good lime and a cement of pounded brick, or, which is better, river sand, which latter forms a layer more uneven, and better fitted to attach the second smooth layer to its surface. When the first layer is perfectly dry, wet it again with water, in proportion to its dryness, that the second layer may more easily incorporate with it. The second layer is composed of lime, slaked in the air, and exposed for a whole year, and of river sand of an equal grain, and moderately fine. The surface of this second layer must be uniformly even. To give a fine polish to this surface, a sheet of paper should be applied on it, and the trowel passed and repassed over the paper. The workman must not extend the layer over a greater space than the painter is able to finish in a day, as it is necessary that the ground should always be fresh and moist under his pencil. The ground being thus prepared, the painter begins his work; but as painting in fresco must be executed rapidly, and as there is not time to retouch any of the strokes of the brush with good effect, he will first have taken care to provide himself with large finished drawings in chalk, or paintings in distemper, of the same size as the work which he has to paint, so that he shall have only to copy these drawings on the wall. The painter traces the outlines of the figures on the plaister, by passing a steel point over them, or pricking them closely, and passing very finely powdered charcoal through the pricked holes. All natural earths are good for painting in fresco. The colours are ground, and tempered with water. It is to be remarked, that all the colours used in this method of painting brighten as they grow dry, excepting the pavonazzo, or red varnish, the brownish red ochre, ruth ochre, and the blacks, particularly those that are passed through the fire.

The best colours are white, made of old lime and white marble dust, (the proportional quantity of the latter depends on the quality of the lime, and must be found by trial, as too great a quantity of marble dust will turn the colour black,) ultramine blue, the black of charcoal, yellow ochre, burnt vitriol, red earth, green of Verona, Venetian black, and burnt ochre. Other colours, which require to be used with greater precaution, are amel, or enamel blue, and cinnabar. Enamel blue must be applied instantaneously, and while the lime is very moist, otherwise it will not incorporate; and if you retouch with it, you must do it an hour or more after the first application of it, in order to increase its lustre. Cinnabar has a splendour almost beyond all other colours, which it loses when mixed with lime. It may, however, be employed in places not exposed to the air, if carefully prepared. For this purpose, reduce a quantity of the purest cinnabar to powder, put it into an earthen vessel, and pour lime water on it two or three times. By this process the cinnabar receives some impression from the lime water, and you may then use it with greater safety. The white of lime is formed by mixing lime, slaked a long time before, with good water. The lime deposits a sediment in the vessel, when the water is poured off; this sediment is the white of lime. Ochres of all kinds make good colours for fresco, being previously burnt in iron boxes. Ultramarine never changes, and seems to communicate its permanent quality to the colours with which it is mixed.

*Distemper.*—Until the discovery of oil-painting, the methods most generally adopted by all Italian painters were those of distemper and fresco. In distemper, when they painted on boards, they often pasted over the boards a piece of fine cloth, to prevent them from parting; they then laid on a layer of white, after which, having tempered their colours with water and paste, (or rather with water and yolks of eggs beat together with little fig-tree branches, the milk of which they mixed with the eggs,) they painted their picture with this mixture. All colours are proper for distemper, except the white of lime, which is used in fresco only.

*Oil Painting.*—The principal advantage of oil painting over other methods, consists in the colours drying less speedily, so that it allows the painter to finish, smooth, and retouch his works with greater care and precision. The colours also being more blended together, produce more agreeable gradations, and a more delicate effect.

*Of Painting Flesh.*—Principal colours from which all the tints of the flesh are made, and their qualities in painting: Flake white is the best white known to us. This colour should be ground with the finest poppy oil that can be procured. White comes forward to the eye with yellows and reds, but retires with blues and greens. It is the nature of all whites to sink into whatever ground they are laid on, therefore they should be laid on white grounds. Ivory black is the best black; it is a colour which mixes kindly with all the others. It is the true shade for blue; and when mixed with a little Indian red, it is the best general shadow colour that can be used. It is generally ground with linseed oil, and used with drying oil. Black is a cold, retiring colour. Ultramarine is the finest blue in the world: it is a tender retiring colour, and never glares, and is a beautiful glazing colour. It is used with poppy oil. Lake is a tender deep red, but of no strong body; therefore it should be strengthened with Indian red. It is the best glazing colour that can be used. It is ground with linseed oil, and used with drying oil. Burnt umber is a fine warm brown, and a good working strong colour; it is of great use in the hair, and mixes finely with the warm shade.

*Process.*—The process of oil painting, particularly in the colouring of flesh and in landscape, is to be divided into three stages, or paintings. The colours and tints necessary for the first and second stages of painting flesh, are; 1, flake, or fine white; 2, light ochre and its tints; 3, light red and its two tints; 4, vermilion and its tint; 5, a tint composed of lake, vermilion, and white; 6, rose tint; 7, blue tint; 8, lead tint; 9, green tint; 10, half shade tint, made of Indian red and white; 11, shade tint; 12, red shades; 13, warm shade. The finishing palette for a complexion requires 5 more: 1, carmine and its tint; 2, lake; 3, brown pink; 4, ivory black; 5, Prussian blue.

*First Stage, or Dead Colouring of Flesh.*—The first lay of colours consists of two parts; the one is the work of the shadows only, and the other that of the lights. The work of the shadows is to make out all the drawing very correctly with the shade tint, in the same manner as if it was to be done with this colour only, and remember to drive or lay the colour sparingly. The lights should be all laid in with the light red tint, in different degrees, as we see them in nature. These two colours united, produce a clean, tender, middle tint. In uniting the lights and shades, you should use a long softener, about the size of a large swan quill, which will help to bring the work into character, and leave the colouring more delicate; then go over the darkest shadows with the red or warm shade, which will finish the first lay. The warm shade being laid on the shade tint, improves it to a warmer hue; but if laid instead of the shade tints, it will dirty and spoil the colours it mixes with; and if the red shade is laid first instead of the shade tint, the shadows would then appear too red; therefore, notwithstanding these two colours are the best that can be for the shadows, yet they are too strong to be laid alone, which is a proof of the great use and merit of the shade tint. Here we may observe, that the shade and light red tints are so friendly in their nature, than even in continually altering and changing, they always produce a clean colour of a pearly hue.

*Next.*—In order to finish the first painting, improve the reds and yellows to the complexion, and after them the blues; observing that the blues on the reds make the purple, and on the yellows produce the green. The same method is to be understood of the shadows; but be sure to leave them clean, and not too dark; therefore allowance should be made in the grounds with the light red, because glazing them will make them darker. When the cloth is of a dark or bad colour, there must be a strong body of colour laid all over the shadows, such as will not sink into the ground, but appear warm, and a little lighter than the life, so that it may be of the same forwardness to finish as if it had been a light ground; therefore the business of dead-colouring is, that you leave it always in the same order for finishing, though the colour of the cloth is quite the reverse.

*Second Painting, or Second Stage.*—The second painting begins with laying on the least quantity that can be of poppy-oil; then wipe it almost all off, with a dry piece of a silk handkerchief. The second painting is also divided into two parts: one the first lay of the second painting; which is scumbling the lights, and glazing the shadows; the other, finishing the complexion with the virgin tints, and improving, as far as you can without daubing.

*First.*—Scumbling is going over the lights where they are to be changed, with the light red tints or some other of their own colours, such as will always clear and improve the complexion, with short stiff pencils, but such parts only as require it, otherwise the beauty of the first painting will be spoiled. The light red tint improved is the best colour for scumbling and improving the complexion in general. Where the shadows and drawing are to be corrected, you should do it with the shade tint, by driving the colour very stiff and bare, that you may the easier retouch and change it with the finishing tints. Some parts of the shadows should be glazed with some of the transparent shadow colours, such as will improve and come very near to the life; but be sure not to lay on too much of it, for fear of losing the hue of the first painting, the ground of which should always appear through the glazing. Be very careful, in uniting the lights and shades, that they do not mix dead and mealy; for the more the lights mix with the shades, the more mealy the shades will appear. Thus far the complexion is prepared and improved, in order to receive the virgin tints.

*Third Painting, or Finishing.*—It is to be supposed the complexion now wants very little more than a few light touches; therefore there will be no occasion for oiling. Begin with correcting all the glazing first, where the glazing serves as a ground or under part; then determine what should be done next, before you do it, so that you may be able to make the alteration on the part with one stroke of the pencil. By this method you preserve both the glazing and the tints; but if it happens that you cannot lay such a variety of tints and finishing colours as you intended, it is much better to leave off while the work is safe and in good order; because those few touches, which would endanger the beauty of the colouring, may easily be done, if you have patience to stay till the colours are dry; and then, without oiling, add those finishings with free light strokes of the pencil.

*Of Painting Draperies.*—The right method of painting draperies in general, is to make out the whole or the first lay with three colours only, *viz.* the lights, middle tint, and shade tint. In the first lay, the high lights should be laid with plenty of stiff colours and then shaped and softened into character with the middle tint very correctly. Where the gradations of the lights are slow, as in the large parts, it will be proper to lay the middle tint first at their extremities, with a tool that will drive their colour, and leave it sparingly; because the lights will mix and lie the better upon it. Next make out all the parts of the shadows with the tint driven bare. After this comes the middle tint, for the several lights and gradations; which should be very nicely wrought up to character without touching any of the high lights which finish the first lay. The reflects and finishings tints are in general the antipathies of the first lays; they will, without great care, dirty the colours on which they are laid, and therefore shuld be laid with a delicate light touch, without softening. If it is overdone, endeavour to recover it with the colour of the part on which it was laid; this may be done directly, or when it is dry. Whether the reflects proceed from the same colour, or any other, the method of using them is the same. It often happens that the colour of the cloth is very improper for the ground of the drapery; and when it is so, you should change it with those colours which are most proper to improve and support the finishing colours.

*White Satin.*—All whites should be painted on white grounds, laid with a good body of colour, because this colour sinks more into the ground than any other. There are four degrees of colours in the first lay, to white satin. The first is the fine white for the lights; the second is the first tint, which is made of fine white and a little ivory black, mixed to an exact middle degree between the white and the middle tint. This colour follows the white, and it is with this you should shape the lights into character before you lay on any other: and take care that this first tint appears distinctly between the white and the middle tint, otherwise the beauty and the character of the satin will be spoiled. The middle tint should be made of white, black, and a little Indian red. These three colours are very friendly, and mix to a beautiful clear colour of a pearly hue, which has the true brightness and warmth of the general hue of the satin. Remember to allow for the red hue changing a little to the lead. We often see a little blue used in the first tint of white satin.

*Changeable Colours.*—Changeable colours are made with four principal tints, *viz.* the high lights, middle tint, shade tint, and reflecting tint. The greatest art lies in finding the exact colour of the middle tint, because it has more of the general hue of the silk than any of the others. The shade tint is of the same hue with the middle tint, though it is dark enough for the shadows. The high lights, though often very different from the middle tint, should be of friendly-working colour, that will, in mixing with it, produce a tint of a clean hue. The method of painting silks is to make out the folds with the shade tint, and then fill them up in the lights with the middle tint. This first lay should be done to your satisfaction before you add any other colours; and the stiffer the middle tint is used, the better the high lights may be laid upon it. The reflecting tints fall generally upon the gradating harsh shades, and should be laid with tender touches sparingly, for fear of spoiling the first lay. This method of painting answers for all coloured silks, as well as changeable; with this difference only, that the plain colours require not so much art in matching the tints, as the changeable do. The last part of the work is the finishing and strengthening the shadows with an obscure tint, a little inclining to a mellowish hue; such as will not catch the eye, and interrupt the beauty of the lights.

*Black.*—The best ground for black is light red for the lights, an Indian red and a little black for the shadows. The finishing colours are, for the lights, black, white, and a little lake. The middle tint has less white, and more lake and black: the shade tint is made of an equal quantity of lake and brown pink, with a very little black. The method of painting black is very different from that of other colours; for as in these the principal thing is to leave their lights clear and brilliant; so in black, it is to keep the shadows clear and transparent. Therefore begin with the shade tint, and glaze over all the shadows with it. Next lay in the darkest shadows with black, and a little of the shade tint, very correctly. After that, fill up the whole breadth of lights with the middle tint only. All which should be done exactly to the character of the satin, velvet, cloth, &c. &c. and then finish with the high lights. Though the grounds mentioned for the draperies are absolutely necessary for the principal and nearest figures in a picture, such as a single portrait, or the like; yet for figures which are placed behind the principal or front figures, their ground should be always fainter in proportion to their local finishing colours.

*Linen.*—The colours used in linen are the same as those in white satin, except the first tint, which is made of white and ultramarine ashes, instead of the black, and mixed to a very light bluish tint.

*Of Painting Back Grounds.*—The principal colours that are necessary for painting of back grounds, as walls, buildings, or the like, are white, black, Indian red, light and brown ochre, Prussian and burnt umber; from which the eight principal tints are made, as follows: 1. Pearl is made of black, white, and a little Indian red. 2. Lead, of black and white, mixed to a dark lead colour. 3. Yellow, of a brown ochre and white. 4. Olive, of light ochre; Prussian and white. 5. Flesh, of Indian red and white, mixed to a little tint. 6. Murrey, of Indian red, white, and a little black, mixed to a kind of purple, of a middle tint. 7. Stone, of white, umber, black, and Indian red. 8. Dark shade, or black and Indian red only. Here the lead tint serves for the blues, the flesh tint mixes agreeably with the lead, and the murrey is a very good blending colour, and of great use where the olive is too strong; the umber, white, and dark shade, will produce a fine variety of stone colours; the dark shade and umber, used plentifully with drying oil, make an excellent warm shadow colour. All the colours should be laid with drying oil only, because they mix and set the better with the softener.

*Process.*—The process of painting back grounds is divided into two parts in stages: the first is the work of the first lay; the second that of the finishing tints. Begin the first lay from the shadowed side of the head, and paint the lights first; from them go into the gradations and shadows, which should be done with a stiffish tool, very sparingly, with the dark shade and white, a little changed with the colours that will give it more of the required hue, but very near in regard to tone and the colours that join them. This do with the dark shade and strength, leaving them like mezzotinto. The dark and warm shadows should be laid before umber, driven with drying oil. If those colours were laid on first, they would spoil the transparency, which is their greatest beauty. The more the first lay is driven, the easier and better you may change it with the finishing tints, therefore you may lay them with the greater body. The second part is to follow directly, whilst the first lay is wet, with those tints that are most proper to harmonize and finish with.

Begin with the lights first, and remember, as you heighten and finish them, to do it with warmer colours; and let those be accompanied with fine tender cold tints. The lightest parts of the ground should be painted with a variety of light warm clear colours, which vanish and lose their strength imperceptibly in their gradations. Take care that you do not cover too much of the first lay, but consider it as the principal colour. From the lights go to the gradations and shadows: for when the lights are well adapted to produce and support the figure, it is easy to fall from them into whatever kind of shadows you find most proper; then soften and blend the whole with a long large hog-tool; which, with the strength and body of the drying oil, will melt and sweeten altogether, in such a manner as will seem surprisingly finished. Remember the tints will sink, and lose a little of their strength and beauty in drying. All grounds, as walls, &c. should be finished at one painting; but if they want to be changed, glaze them with a little of the dark shade and drying oil, driven very bare; on which with a few light touches of the colour that is wanting, you may improve their hue. The dark shadows may also be strengthened and improved by glazing, which should be done after the figures are nearly finished, for fear of making them too strong. Curtains should be dead-coloured when we paint the ground; and should be done with clean colours, of a near hue to the intended curtain, such as will support the finishing colours; do it with a tender sort of keeping, and near in regard to their tone in the lights, but much softer in the shadows; all which should be mixed and broken with the colours of the ground. It will often happen, that we cannot make the folds the first painting; we should then leave the masses of light and shadow, in regard to the keeping of the picture, broad and well united together, such as may seem easy to finish on. The colours of the landscapes in back grounds, should be broke and softened also with those of the parts which join them. This method will make all the parts of the ground as it were of one piece. The sky should be broke with the lead and the flesh tints. The murrey tint is of great use in the grounds of distant objects; and the umber and dark shades, in the near grounds. The greens should be more beautiful than you intend them, because they will fade and grow darker. After all is painted, go over the whole very lightly with the softener, as you did the grounds, which will make it look agreeably finished.

*Of Painting Landscapes.*—The principal colours used in landscapes are, 1. Flake white; 2. White lead or common white; 3. Fine light ochre; 4. Brown ochre; 5. Brown pink; 6. Burnt umber; 7. Ivory black; 8. Prussian blue; 9. Ultramarine; 10. Terreverte; 11. Lake; 12. Indian red; 13. Vermilion, or native cinnabar; 14. King's yellow. The principal tints are, 1. Light ochre, and white; 2. Light ochre, Prussian blue, and white; 3. Light ochre and Prussian blue; 4. The same darker; 5. Terreverte and Prussian blue; 6. Brown pink and Prussian blue, 7. Brown pink and brown ochre; 8. Brown pink, ochre, and Prussian blue; 9. Indian red and white; 10. Ivory black, Indian red, and lake. The colours necessary for dead colouring are: common white, light ochre, brown ochre, burnt umber, Indian red, ivory black, and Prussian blue. The principal colours and tints for painting the sky are, fine white, ultramarine, Prussian blue, light ochre, vermilion, lake, and Indian red. The tints are, a fine azure, lighter azure, light ochre, and white vermilion and white; and a tint made of white, a little vermilion, and some of the light azure at your discretion.

*Process.*—Sketch or rub in your design faintly, with burnt umber used with drying oil, and a little oil of turpentine, leaving the colour of the cloth for the lights. Remember, in doing this, to leave no part of the shadows so dark as you intend the first lay or dead colouring, which also is to be lighter than the finishing colours. Though the foliage of the trees is only rubbed in faintly, yet the trunks and bodies should be in their proper shapes, with their breadths of light and shadows. All kind of buildings should be done in the same manner, leaving the colour of the cloth for their lights. The figure on the fore ground may also be sketched in the same manner, and then left to dry.

*First Painting, or Dead Colouring.*—Let the first lay or dead colouring be without any bright, glaring, or strong dark colours; so that the effect is made more to receive and preserve the finishing colours, than to shew them in their first painting. The sky should be done first, then all the distances; and so work downwards to the middle group, and from that to the fore ground, and nearest parts. Remember, all the parts of each group, as trees, buildings, or the like, are all painted with the group they belong to. The greatest secret in dead colouring is to find the two colours which serve for the ground of shadows in general, the sky excepted; and the method of using them with the lights, the first of which is the dark shade with a little lake in it; the other colour is only burnt umber. These should be a little changed to the natural hue of the objects, and then laid on with drying oil in the same manner as we shade with Indian ink, which is a kind of glazing, and as such they should be left, otherwise they will be dark and heavy, and therefore would be entirely spoiled for the finishing glazing. Both these colours mix and sympathize agreeably with all the lights, but should be laid before them.

*The Sky.*—The sky should be laid with a good body of colours and left with a faint resemblance of the principal clouds, more in the manner of claro-obscure than with finishing colours; the whiter it is left, the better it will bear out and support them; the distances should be made out faint and obscurely, with the dark shades and some of their lights in different degrees, and laid so as best to find and shew their principal parts. All the grounds of the trees should be laid or rubbed in, enough only to leave an idea of their shapes and shadows faintly. The ground of their shadows must be clean, and lighter than their finishing colours. In painting the lights, it is better to incline more to the middle tint, than to the very high lights; and observe to leave them with a sufficient body of clean colours, which will preserve the finishing colours better; all which may be done with a few tints. After this, go over the whole with a sweetener very lightly, which will soften and mix the colours agreeably for finishing.

*Second Painting.*—Begin with the sky, and lay in all the azure, and colours of the horizon; then soften them; after that lay in the general tint of the clouds, and finish on it with the high lights and the other tints that are wanting, with light tender touches; then soften the whole with a sweetener very lightly. The finishing of the sky should be done all at one painting, because the tender character of the clouds will not do so well as when the whole is wet. Observe, that the stiffer the azure and colours of the horizon are laid, the better the clouds may be painted upon them.

*Third and last Painting.*—If oiling is necessary, lay the least quantity that can be; which should be done with a stump tool or pencil, proportioned to the place that is to be oiled, so as to oil no more than is wanted: then wipe the whole place that is oiled, with a piece of silk handkerchief. When going to finish any objects, remember to use a great variety of tints, very nearly of the same colour, but most of all when finishing trees. This gives a richness to the colouring, and produces harmony. The greens will fade, and grow darker; therefore it is highly necessary to improve and force them, by exaggerating the lights, and making an allowance in using them so much the lighter. For the same reason, take great care not to overcharge and spoil the beauty of the glazing; for if you do, it will be dull and heavy, and will consequently grow darker. The method of painting near trees is, to make the first lay very near to nature, though not quite so dark, but more in the degree of a middle tint, and follow it with strengthening the shadows; then the middle tints; and last of all lay the high lights and finishing colours. All this cannot be done as it should be, at one painting; therefore the best way is, to do no more than the first lay with the faint shadows, and leave it to dry. Then begin with improving the middle tints and shadows, and let them dry. The third and last work is, adding all the lights and finishing colours in the best manner you are able. This method of leaving the first and second parts to dry separately, not only makes the whole much easier, and more agreeable, but leaves the colours in the greatest perfection; because most of the work may be done with scumbling and glazing, and some parts without oiling. The lights also may be laid with a better body of colour, which will not be mixed and spoiled with the wet ground. The figures in the landscapes are the last work of the picture; those in the fore-ground should be done first, and those in the distances should be done next; for after the figures in the first and farthest group are painted, it will be much easier to find the proportions of those in the middle parts of the picture. And observe, that the shadows of the figures should be of the same hue, or colour, with those of the group or place they are in.

*Qualities of the above Colours when used in Miniature.*—*Yellows.* Gall-stone is one of the finest and brightest colours, and a lasting one: but it should be sparingly used in the flesh tints, its brilliancy being apt to overpower all the other colours. Terra Sienna is a bright yellow earth, somewhat of a greasy nature, and is used as a warm yellow; but when burnt, is more beautiful, partaking of three tints, yellow, red, and brown. Nottingham ochre works well, but on account of its heavy qualities must be used with caution. Roman ochre is used with success in miniature painting, as it works, when properly proportioned with gum water, extremely sharp and neat; and being in itself a warm colour, communicates that quality to the tints it is worked in. Naples yellow, although adopted by some artists, is of a sickly hue, and has this very bad quality, that it absorbs all colours that are either worked on it, or mixed with it.

*Blues.* Ultramarine excels all others in permanency. Prussian blue has no substitute, on account of its strength of effect and transparency. Smalt is so hard that nothing but an agate flag and muller will pulverize it sufficiently. It is not to be depended on for permanency. Indigo is a useful blue, though it must be sparingly used, on account of its extreme depth of colour, nearly approaching to black; the best is called the rock indigo. The way to judge of its qualities is to break it, and, if good, it will have a copperish hue, but if bad, it will be of a dead blackish cast. Chinese vermilion, when good, is a bright red, and useful in miniature pictures, though not to be freely used, its opacity rendering it dangerous to mix much with other colours; but by itself, in touching the parts that require extreme brightness, it is of wonderful service. It is very difficult to find the real kind—the common vermilion, mixed with lake or carmine, being a general substitute; but the spurious and the genuine kind very materially differ in working, the former being thick and heavy, the other the contrary. India red is an excellent colour, not only for touching the deep red parts, but likewise in strong flesh tints, in bright back-grounds, and draperies.

*Browns.* Umber is very greasy, and mixes unkindly; but, when burnt, is very useful in many parts of miniature. Terra de Cassel, or Vandyck brown, so called from the very great estimation the inimitable painter of that name held it in, is the first rich brown in the world; in itself producing a more beautiful colour than can be formed by the junction of any colours whatever.

*Ivory.*—Of ivory there are various kinds, the distinction of which in this art is of very material consequence. Ivory, newly cut, and full of sap, is not easily to be judged of; the general transparency it exhibits in that state, almost precluding the possibility of discovering whether it is coarse-grained or fine, streaky or the contrary, unless to the artist who, by a long course of experience, is familiarized to it. The best way to discover the quality of it is, by holding it grainways to the light, then holding it up and looking through it, still turning it from side to side, and very narrowly observing whether there are any streaks in it; this you will, unless the ivory is very freshly cut, easily discover: and in this you cannot be too particular. There is a species of ivory which is very bad for painting on, although it has no streaks in it, being of a horny coarse nature, which will never suffer the colours to be thrown out in the brilliant manner a fine species of ivory will; you are, therefore, not only to be cautious in choosing ivory free from streaks, but likewise that which has the finest grain, and close.—Having instructed in the mode of choosing ivory, and having prepared it for painting on, we now proceed to give—

*Instructions for Mixing Compound Tints for the Face.*—Purple is formed of either ultramarine, Prussian blue, smalt, or indigo, mixed with either carmine or drop lake. Ultramarine, although the most beautiful and brilliant of colours by itself, yet in any mixture it loses that perfection, but still retains a sufficient share of brightness to render it a desirable tint in the purplish gray shadows of the face. Prussian blue, mixed as before-mentioned, makes a bright or dark purple, according as the quantities of either colours are proportioned; but indigo makes still darker, owing to its great natural depth of colour. Smalt and carmine, or lake, form nearly the same tint as ultramarine, and may be used nearly for the same purposes.

*Gray.* Of gray tints there are various kinds, according to the subjects they are required for. A warm gray tint may be made by duly portioning burnt terra Sienna, Prussian blue, and drop lake; the more terra Sienna in it, the warmer the tint; the more Prussian blue and lake, the colder. Another gray tint, used with success by some eminent miniature painters, was composed of Prussian blue and Chinese vermilion, but on account of the unkind manner with which vermilion incorporates with any other colour, it required a greater proportion of gum than ordinary to make them work or keep together. A third gray tint, which is an excellent one, is formed of drop lake, sap-green, and Prussian blue.

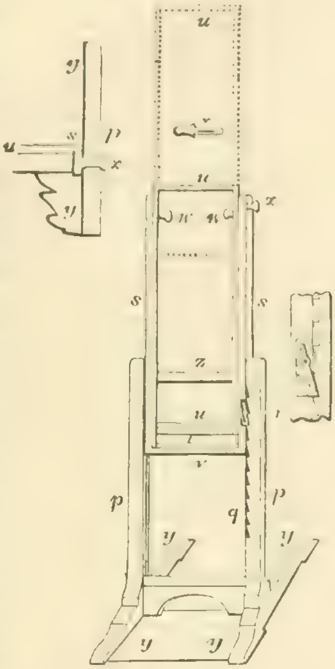
*Olive Tints.* A very fine olive tint is formed of gall-stone, Nottingham ochre, and carmine, or lake; and another of sap-green and lake simply.

*Of Colours proper for Men's Draperies.*—We shall, under this head, make some general observations; the first of which is, that in all cloth draperies for men's portraits, it is necessary to add some flake white; as it not only gives the colour the dead appearance which cloth exhibits, but likewise its being incorporated with the flake white, gives it a body which makes the flesh tints appear to more advantage. The next observation is, that in grinding up your draperies, you are to make them appear several degrees lighter in colour than you want them to be when dry—for this reason; the flake white is a colour so very heavy, that, after you float in your coat, it will sink to the bottom, and leave your colours several degrees darker than when it was wet; and finally you are not to be too heavy or thick in floating in your draperies, but merely to see that your colour is evenly spread over the part. Black drapery is formed of lamp black burnt, and flake white; and must be laid in with a good deal of the latter, as otherwise it will be very difficult to manage the shadows so as to produce a pleasing effect. Scarlet is a colour very difficult to lay down rules for making, as in some pictures it is dangerous to make it too bright, for fear of hurting the effect of the face by its brilliancy catching the eye too readily; consequently, if the subject you are painting from life is very pale, you run a very great risk by annexing a very bright scarlet to his picture. We shall therefore only mention that a very bright scarlet is made of Chinese vermilion and carmine, ground together, (without any flake and white;) and if you want it still rendered brighter when it is dry, fill your pencil with plain carmine, mixed with thin gum-water, and glaze over it nicely; but if, on the contrary, you wish to sadden, or take away a share of its brilliancy, add a little flake white to it, and that will have the desired effect.

*List of several of the most eminent Painters of the Old School, with a Scale of their different Merits, so far as regards Composition, Design, Colouring, and Expression.*

| School. | Name. Date of Birth and Death. | Composition. | Design. | Colouring. | Expression. |
|---|---|---|---|---|---|
| Lombard, ... | Albano, born 1578, died 1660, ........ | 14 | 14 | 10 | 6 |
| Flemish,.... | Albert Durer, born 1470, died 1528, .. | 8 | 10 | 10 | 8 |
| Roman and Florentine, | Andrea del Sarte, born 1478, died 1530, | 12 | 16 | 9 | 8 |
| Roman, .... | Baroche, born 1528, died 1612, ...... | 14 | 15 | 6 | 10 |
| Venetian, ... | James Bassau, born 1553, died 1613, .. | 6 | 8 | 17 | 0 |
| Venetian,.... | John Bellin, born 1421, died 1501,.... | 4 | 6 | 14 | 0 |
| French, .... | Bourdon, born 1513, died 1588, ...... | 10 | 8 | 8 | 4 |
| French, .... | Le Brun, born 1620, died 1690, ...... | 16 | 16 | 8 | 16 |
| French, .... | Claude Lorraine, born 1600, died 1682, | 18 | 18 | 16 | 0 |
| Lombard,.... | Annibal Carracci, born 1557, died 1606, | 15 | 17 | 13 | 13 |
| Lombard,.... | Correggio, born 1494, died 1534,...... | 13 | 13 | 17 | 12 |
| Roman,..... | Daniel de Volterra, born 1509, died 1556, | 12 | 15 | 5 | 8 |
| Flemish,.... | Diepembeck, born 1608, ............. | 11 | 10 | 14 | 6 |
| Lombard, ... | Dominechino, born 1581, died 1641,.... | 15 | 17 | 9 | 17 |
| Venetian, ... | Georgioni, born 1477, died 1511,...... | 8 | 9 | 18 | 4 |
| Lombard, ... | Guido, born 1575, died 1642, ........ | 0 | 18 | 9 | 12 |
| Flemish, .... | Holbein, born 1498, died 1544, ........ | 9 | 10 | 16 | 3 |
| Flemish, .... | James Jordans, born 1594, died 1678,.. | 10 | 8 | 16 | 6 |
| Flemish,.... | Lucio Jordano, born 1632, died 1705,.. | 13 | 12 | 9 | 6 |
| Roman,..... | Julio Romano, born 1446, died 1500,... | 15 | 16 | 4 | 14 |
| Lombard, ... | Lanfranc, born 1581, died 1647, ....... | 14 | 13 | 10 | 5 |
| Roman,..... | Leonardo da Vinci, born 1445, died 1520, | 15 | 16 | 4 | 14 |
| Flemish,.... | Lucas de Leide, born 1495, died 1535, | 8 | 6 | 6 | 4 |
| Roman,... | Michael Angelo Buonarotti, born 1474, died 1564,.................... | 8 | 18 | 4 | 8 |
| Lombard, ... | Michael Angelo Caravaggio, .......... | 6 | 8 | 16 | 0 |
| Venetian, ... | Muticus, born 1528, died 1590,........ | 6 | 8 | 15 | 4 |
| Flemish, .... | Otho Venius, born 1556, died 1634,.... | 13 | 14 | 10 | 10 |
| Venetian, ... | Palma, the elder, born 1460, died 1556, | 5 | 6 | 16 | 0 |
| Venetian, ... | Palma, the younger, born 1544, died 1628, | 12 | 9 | 14 | 6 |
| Roman,..... | Parmesan, ......................... | 10 | 15 | 6 | 6 |
| Venetian,.... | Paul Veronese, born 1532, died 1588,.. | 15 | 10 | 16 | 3 |
| Roman,..... | Perin del Vague, born 1500, died 1547, | 15 | 16 | 7 | 6 |
| Roman,..... | Pietro de Cortona, born 1596, died 1669, | 16 | 14 | 12 | 6 |
| Roman,..... | Pietro Perugino, born 1524, died 1602, | 4 | 12 | 10 | 4 |
| Roman, .. | Polidore de Caravaggio, born 1596, died 1643,................... | 10 | 17 | 0 | 15 |
| Venetian,.... | Pordenon, ......................... | 8 | 14 | 17 | 5 |
| French,..... | Nicholas Poussin, born 1594, died 1665, | 15 | 17 | 6 | 15 |
| Roman,..... | Primatrice, died 1570, .............. | 15 | 14 | 7 | 10 |
| Roman,..... | Raphael, born 1483, died 1520, ....... | 17 | 18 | 12 | 18 |
| Flemish,.... | Rembrandt, born 1606, died 1668, .... | 15 | 6 | 17 | 12 |
| Flemish,.... | Rubens, born 1577, died 1640,........ | 18 | 13 | 17 | 17 |
| Roman,..... | Salviati, born 1510, died 1563,........ | 13 | 15 | 8 | 8 |
| French,..... | Le Sueur, born 1617, died 1655,...... | 15 | 15 | 4 | 15 |
| Flemish,.... | Teniers, born 1582, died 1649,........ | 15 | 12 | 13 | 6 |
| Roman,..... | Pietro Testo, born 1611, died 1650,.... | 11 | 15 | 0 | 6 |
| Venetian,.... | Tintoretto, born 1512, died 1591,...... | 15 | 14 | 16 | 4 |
| Venetian,.... | Titian, born 1477, died 1576, ......... | 12 | 15 | 18 | 6 |
| Flemish,.... | Vandyck, born 1599, died 1641, ...... | 15 | 10 | 17 | 13 |
| Roman, ..... | Vanius, born 1556, died 1631,........ | 13 | 15 | 12 | 13 |
| Roman, ..... | Tadee Zucree, born 1529, died 1556, .. | 13 | 14 | 10 | 9 |

*Description of a Rest for the Use of Painters, by Wm. Brockedon, Esq.*—The painter's-rest is intended as a substitute for the common maul-stick, the inconvenience of which has been often felt by painters; sometimes from its increasing the pressure, to the fatigue of the hand, which also supports the pallet; often, in spite of the padding with which the end is armed, doing injury to the picture, if not quite dry. These disadvantages are obviated by the following machine; which consists of a frame, with feet of unequal length, the longest being always placed under the easel, that the pressure of the hand may not turn it over towards the picture. In the outer frame of the rest, a sliding frame is made to rise, and be fixed by a ratchet: if the height required exceed the extent of the ratchet, the swing frame will again extend the elevation, owing to its pivots being placed out of the centre. The machine is capable of any adjustment, from the low sitting elevation of an invalid to a very high standing one, and it is firm enough to steady the hand perfectly.



This figure is a perspective view of the rest; *p p*, two standards, framed together near the foot-board by a cross bar, and by the bar *z* at the top; *q*, a rack, cut in the right-hand one; *r*, the click, catching in it; *s*, *s*, two other standards, framed together only by the bars *t* and *v*, having rabbets along their outsides, fitting into grooves in the inside of the standards *p p*, which serve as guides to them when sliding up and down. The frame *s s* is supported at any required height by the click *r*; *u u*, a long frame, filling the space between the standards *s s*; it is fixed to these latter by the thumb-screws *w w*. The upper part of this frame forms the rest for the arm; and, in order to prevent it from turning on the screws *w w*, a pin or bolt *x*, pushes in, to fix it: it has a loop-hole, through which a smaller pin passes, to keep it to its place. By withdrawing the little pin *x*, the frame *u u* may be turned round on the screws *w w*, and secured by them and by the bolt, as shewn by the dotted lines, to give an additional elevation; the same rack *q* giving the intermediate height between this position and the former. The left-hand figure shews a bird's-eye view of one foot *y y*, and standards *p* and *s*, and part of the frame *u*. The painter gives additional steadiness to the rest, by putting one foot on the foot-board *y y* in front. The whole rest inclines, from top to bottom, about as much as an easel in use generally does, and the long feet go under the canvass, to let it approach near enough.

**PAKFONG**, or **White Copper**, a metal composed of copper, nickel, and zinc. The zinc amounts to nearly one half of the whole, and the proportions of copper and nickel are as 5 to 13. This compound metal is much used among the Chinese.

**PALÆSTRA**, in Grecian Antiquity, a public building, where the youth exercised themselves, in wrestling, running, playing at quoits, &c.

**PALAMEDEA**, a genus of birds, belonging to the order of grallæ. The character of this genus is, the bill bends down at the point with a horn, or with a tuft of feathers erect near the base of it: the nostrils are oval; the toes are divided almost to their origin, with a small membrane between the bottoms of each.

**PALATE**, in Anatomy, the flesh that composes the roof, or the upper and inner part, of the mouth.

**PALATINE** *Counties of England*, are Chester, Durham, and Lancaster, the owners of which, the Earl of Chester, the Bishop of Durham, and the Duke of Lancaster, can, or may, or could, pardon treasons, murders, and felonies, appoint their own judges, justices, and issue writs and indictments, as the king can in the other counties that are not palatinate.

**PALILICUM**, another name for the star *Aldebaran*.

**PALING**, in Agriculture, a kind of fence-work for fruit trees. It is also a fence made by stakes being driven into the ground.

**PALISADES**, stakes made of strong split wood, used in fortification, and for the support or defence of embankments.

**PALISSE**, in Heraldry, a bearing like a range of palisades before a fortification, represented on a fosse, rising up a considerable height and pointed at top, with the field appearing before them.

**PALLADIUM.** This is a new metal first found by Dr. Wollaston associated with platina, among the grains of which he supposes its ore to exist, or an alloy of it with irridium and osmium, scarcely distinguishable from the crude platina, though it is hardier and heavier. Palladium is of a greyish white colour, scarcely distinguishable from platina, and takes a good polish. It is ductile, and very malleable; and being reduced into thin slips, is flexible, but not very elastic. Its fracture is fibrous and in diverging striæ, shewing a kind of crystalline arrangement. In hardness it is superior to wrought iron. Its specific gravity is from 10·9 to 11·8.

**Palladium**, a statue of Minerva, which the Trojans imagined fell from heaven, and that their city could not be taken whilst that remained in it.

**PALLAS**, one of the new planets discovered by Dr. Olbers, March 28, 1802. It is situated between the orbits of Mars and Jupiter, and is nearly of the same magnitude with Ceres, but of a less ruddy colour. It is surronnded with a nebulosity of less extent, and performs its annual revolution in nearly the same period. The planet Pallas, however, is distinguished in a very remarkable manner from Ceres and all other primary planets, by the immense inclination of its orbit. While these bodies are revolving round the sun in almost circular paths, rising only a few degrees above the plane of the ecliptic, Pallas ascends above this plane at an angle of about thirty-five degs., which is nearly five times greater than the inclination of Mercury. From the eccentricity of Pallas being greater than that of Ceres, or from a difference of position in the line of their apsides, while their mean distances are nearly equal, the orbits of these two planets mutually intersect each other; a phenomenon which is altogether anomalous in the solar system.

**PALLET**, among Painters, a little oval table or piece of wood, or ivory, very thin and smooth; on and round which the painters place the several colours they have occasion for, to be ready for the pencil. The middle serves to mix the colours on, and to make the tints required in the work. It has no handle, but instead thereof a hole at one end to put the thumb through to hold it.

**Pallet**, among Potters, crucible makers, &c., a wooden instrument, almost the only one they use for forming, beating, and rounding their works: they have several kinds; the largest are oval, with a handle; others are round, or hollowed triangularly; others, in fine, are in manner of large knives, serving to cut off whatever is superfluous on the moulds of their work.

**Pallet**, in Gilding, an instrument made of a squirrel's tail, to take up the gold leaves from the pillow, and to apply and extend them on the matter to be gilt.

**PALLIUM**, or **Pall**, an archiepiscopal vestment of white woollen cloth, about the breadth of a border, made round, and thrown over the shoulders: upon this border there are two others of the same matter and form, one of which falls down upon the breast and the other upon the back, each having a red cross upon it; several crosses of the same colour being likewise upon the upper part of it about the shoulders. The pall was part of the imperial habit, and originally granted by the emperors to patriarchs, but at present it is given by the pope as a mark of the apostolic power, without which neither the function nor title of archbishop can be assumed by the bishops of his communion.

**PALM**, an ancient long measure taken from the extent of the hand. The Roman palm was of two kinds; the great palm, taken from the length of the hand, answered to our span, and contained twelve digits, or fingers' breadths, or nine Roman inches, equal to about eight and a half English inches. The small palm, from the breadth of the hand, contained four digits or fingers, equal to about three English inches. The Greek palm, or doron, was also of two kinds; the small contained four fingers, equal to little more than three inches; the great palm contained five fingers. The Greek double palm, called dichas, contained also in proportion. The modern palm is different in different places, where it is used. It contains

| | Inc. | Lines. |
|---|---|---|
| At Rome | 8 | 3½ |
| At Naples, according to Riccioli | 8 | 0 |
| Ditto, according to others | 8 | 7 |
| At Genoa | 9 | 9 |
| At Morocco and Fez | 7 | 2 |
| Languedoc, and some other parts of France | 9 | 9 |
| The English palm is | 3 | 0 |

**PALMÆ**, *Palms*, comprehend several genera of plants, with simple stems, which at their summits bear leaves resembling those of ferns, being a composition of leaf and branch.

**PANACEA**, among Physicians, denotes an universal medicine, or a remedy for all diseases.

**PANAX**, (*Gin-Seng*,) a genus of plants belonging to the polygamia class, of which there are nine species.

**PANCREATIC** Juice, a liquid secreted by the pancreas, which is found to be analogous to saliva, and probably serves the same purpose in promoting the digestion of the food.

**PANDECTS**, or Pandectæ, in Jurisprudence, are 50 books of Roman civil law, abridged by Justinian's order; though Papias extends the signification of this word to the books of the Old and New Testament. The original copy (supposed to be) is in the possession of the Medici family at Florence. The pandects of Justinian sufficiently shew how zealously the lawyers and advocates of passive obedience laboured in the cause of prerogative.

**PANEL**, a schedule or roll of such jurors as the sheriff returns to pass upon any trial; and impanelling a jury, is returning their names in such schedule of parchment. In Scots law, the prisoner at the bar is the panel.

Panel, in Joinery, is a tympanum, or square piece of thin wood, sometimes carved, framed or grooved in a larger piece between two upright pieces and two cross pieces.

**PANIC**, denotes an ill-grounded terror or fright. The origin of the phrase is from Pan, one of the captains of Bacchus, who with a few men put a numerous army to rout, by a noise which his soldiers raised in a rockey valley favoured with a great number of echos: for this stratagem making their numbers appear much greater than it really was, the enemy quitted a very commodious encampment, and fled. Hence, all ill-grounded fears, have been called panics, or panic fears.

**PANICUM**, a genus of plants belonging to the triandria class.

Panicum *Miliaceum*. *Millet.*—Millet is of two kinds, the brown and yellow. They are sometimes sown in this country for feeding poultry, and also for dressing; *i. e.* it is divested of the husk by being passed through a mill, when it is equal to rice for the use of the pastry cook. The seed used is from one to two bushels per acre. This is very commonly grown in Italy, and on the shores of the Mediterranean sea, from which large quantities are annually exported to the more northern countries.

**PANTHER.** *See* Felis.

**PAPAVER**, the *Poppy*, a genus of the monogynia order, in the polyandria class of plants; and in the natural method ranking under the 27th order, rhœædæ. The corolla is tetrapetalous, the calyx diphyllous, the capsule bilocular, opening at the pores below a persisting stigma. There are nine species: 1. The somniferum, or somniferous common garden poppy. There are of this a great many varieties, some of them extremely beautiful. The white officinal poppy is one of the varieties of this sort. It grows often to the height of five or six feet, having large flowers both single and double, succeeded by capsules or heads as large as oranges, each containing about 8000 seeds.

**PAPER**, Writing, is, in Europe, manufactured from linen rags chiefly. These rags are first cut or chopped, then dusted, and reduced to pulp in mills, by cylinders, &c. The workman now immerses into the pulp vat a mould composed of wire cloth, and furnished with a frame to retain the stuff. He then draws out as much of this pulp as is necessary for one sheet, over which he places a felt, to absorb the moisture; and thus a felt and sheet of paper are placed alternately, till he has formed six quires of paper. When the last sheet is covered with felt, the whole is pressed, and the sheets are suspended on cords to dry. The next operation is sizing, which is performed by plunging the paper into a vessel of size, containing a small portion of alum. The paper is then dried, and folded into quires of 24 sheets, and finally made up into reams containing 20 quires each.

Blotting paper, drawing, engraving, and printing paper, are prepared much in the same way, but they are not so highly sized. In lieu of rags, barley straw is employed in the manufacture of paper, but it will only serve for common purposes, as it communicates an unpleasant tinge.

*To make Stained Paper.* This is done by applying, by soft brushes, any of the colours used for tinging other substances, after tempering them properly with size or gum water. If the paper is to be of a uniform colour, it must be fixed by several thin coatings, each being suffered to dry before another is applied; otherwise the shade will appear clouded.

*Marbled Paper*, is a sort of paper variously stained, or painted as it were with divers colours; made by applying a sheet on the surface of a liquor, wherein colours, diluted with oil or ox's gall, are suspended. The manner of making it is thus:—A trough is provided of the shape and dimensions of a sheet of the paper to be marbled, and about four fingers deep; this is made of lead or wood well joined, and pitched or primed to contain the liquor. For the liquor, a quarter of a pound of gum tragacanth is macerated four or five days in fair water; this they stir from time to time, and add to it daily fresh water, till it be of a consistency somewhat thinner than oil; then they strain it into the trough. The colours to be applied thereon, for blue, are, indigo ground up with white lead, or Prussian blue and verditer may be used: for green, indigo and orpiment, the one ground and the other tempered, mixed and boiled together with common water; or verdigris, a mixture of Dutch pink and Prussian blue, or verditer, in different proportions: for yellow, orpiment bruised and tempered; or Dutch pink and yellow ochre: for red, the finest lake, ground with raspings of Brasil wood, which has been prepared by boiling half a day; or carmine, rose pink, vermilion, and red lead; the two latter of which should be mixed with rose pink or lake, to bring them to a softer cast: for orange, orange lake, or a mixture of vermilion, or red lead, with Dutch pink: for purple, rose pink and Prussian blue. Into all these colours, properly ground with spirit of wine, they put a little ox or fish gall, which is two or three days old; and if the colours dilate not of themselves sufficiently, they add more gall; on the contrary, if they spread too much, the gall is over-dosed, and must be corrected by adding more of the colour without gall.

For the operation of marbling, when the gum is well settled in the trough, they extend a sheet of paper, and plunge it very shallow into the liquor, suddenly lifting it out again, in order to stir up and raise the subsiding gum towards the surface, and for the more universal impregnating of the liquor. This done, and all the colours ranged in gallipots on the table, where also the trough is placed, they begin by dipping a brush of hog's hair into any colour, commonly the blue first, and sprinkle it on the surface of the liquor: if the colour has been rightly prepared, it will dilate itself duly therein. This done, the red is applied in the like manner, but with another pencil; after this, the yellow; lastly, the green. For white, it is made by only sprinkling fair water, mixed with ox's gall, over the liquor. When all colours are thus floating on the liquor, to give them that agreeable cambletting, which we admire in marble paper, they use a pointed stick; which being applied by drawing it from one side of the trough to the other, with address, stirs up the liquor and fluctuating colours; then with a comb, made of wood, about five inches long, with brass teeth, about two inches in length, and a quarter of an inch distant from each other, taken by the head with both hands, they comb the surface of the liquor in the trough, from one extreme to another, permitting only the teeth to enter; this being performed with a gentle and uniform motion, makes those clouds and undulations on which the beauty of the paper depends. If it be farther desired to have the colours lie in any other fantastical posture, representing serpents, or the like, it is effected with the pointed stick above mentioned, by drawing it over what has been already combed; but this must be done with a dexterous hand, and with a shallow dip into the liquor, circling, as if you would draw some flourish, or figured letter. Lastly, the colours being in this posture, the operator displays and applies on them a sheet of white moistened paper; to do which, artist-like, requires a sleight only to be obtained by practice; because the surfaces of the liquor and the paper are to meet equally in all parts; which done, before the colours have time to soak through, which, unless the paper be very thick, will be in the space of two or three pulses, he lifts up the paper nimbly, and with an even hand; and then, after spreading it a while on a board, hangs it on a line to dry; which, when sufficiently done, they first rub it with a little soap, and then polish it with a marble stone, ivory knob, or glass polishers; or with a burnisher of jasper or agate. It must be observed, that the sprinkling of the colours is to be renewed, and all the other ceremonies performed with the stick and comb, at every application of fresh paper, by reason that every paper takes off all the colour from the liquor.

***Rice Paper***, is a curious sort of paper, made by the Chinese; it is semi-transparent, of a firm texture, and feels somewhat like the article manufactured from the *papyrus*. The Chinese also make paper from the rind or bark of the mulberry tree, the elm, the bamboo, and cotton tree. In fact, every different province has its own provincial paper. The second skin of the bamboo bark is peculiarly soft and white. This they beat in fair water into a pulp, which they take up in large moulds, so that some sheets are above twelve feet in length. They are completed by dipping them in alum water, which serves in place of our size. Each province not only manufactures a paper peculiar to itself, but stains it pink, green, or straw colour, as their fathers from time immemorial have done.

***Ivory Paper***. The properties which render ivory so desirable a subject for the miniature painter, and other artists, are, the evenness and fineness of its grain, its allowing all water colours laid on its surface to be washed out with a soft wet brush, and the facility with which the artist may scrape off the colour from any particular part, by the point of a knife, or other convenient instrument, and thus heighten and add brilliancy to the lights in his painting more expeditiously and efficaciously than can be done in any other way. The high price of ivory, the impossibility of obtaining plates exceeding very moderate dimensions, and the coarseness of grain in the larger of these, and its liability, when thin, to warp by changes of the weather, together with its property of turning yellow by long exposure to the light, owing to the oil which it contains, render some substitute very desirable. The ivory paper we are now about to describe, admits of traces being made on the surface by a hard black lead pencil, which are much easier effaced by Indian rubber than from common drawing paper; and this circumstance, with the extremely fine lines which its hard and even surface is capable of receiving, peculiarly adapts it for the reception of the most delicate pencil drawings and outlines. The colours laid upon it have a greater brilliancy than when laid upon ivory, owing to the superior whiteness of the ground. The following is the process given by Mr. Einslie, of Stratton Ground, Westminster, to the Society of Arts, for which he was voted the sum of thirty guineas:—Take a quarter of a pound of clean parchment cuttings, and put them into a two-quart pan, with nearly as much water as it will hold; boil the mixture gently for four or five hours, adding water from time to time, to supply the place of that driven off by evaporation; then carefully strain the liquor from the dregs through a cloth, and when cold it will form a strong jelly, which may be called size No. 1. Return the dregs of the preceding process into the pan, fill it with water, and again boil it as before for four or five hours; then strain off the liquor, and call it size No. 2. Take three sheets of drawing paper, (outsides will answer the purpose perfectly well, and being much cheaper, are therefore to be preferred,) wet them on both sides with a soft sponge dipped in water, and paste them together with the size No. 2. While they are still wet, lay them on a table, and place them upon a smooth slab of writing slate, of a size somewhat smaller than the paper. Turn up the edges of the paper, and paste them on the back of the slate, and then allow the paper to dry gradually. Wet, as before, three more sheets of the same kind of paper, and paste them on the others, one at a time; cut off with a knife what projects beyond the edges of the slate, and when the whole has become perfectly dry, wrap a small piece of slate in coarse sand paper, and with this rubber make the surface of the paper quite even and smooth Then paste on an inside sheet, which must be quite free from spots or dirt of any kind; cut off the projecting edges as before, and when dry, rub it with fine glass paper, which will produce a perfectly smooth surface. Now, take half a pint of the size No. 1, melt it by a gentle heat, and then stir it into three table-spoons full of fine plaster of Paris; when the mixture is completed, pour it out on the paper, and with a soft wet sponge distribute it as evenly as possible over the surface. Then allow the surface to dry slowly, and rub it again with fine glass paper. Lastly, take a few spoons full of the size No. 1, and mix it with three-fourths its quantity of water; unite the two by a gentle heat, and when the mass has cooled, so as to be in a semi-gelatinous state, pour about one-third of it on the surface of the paper, and spread it evenly with the sponge; when this has dried, pour on another portion, and afterwards the remainder; when the whole has again become dry, rub it over lightly with fine glass paper, and the process is completed; it may, accordingly, be cut away from the slab of slate, and is ready for use.—The quantity of ingredients abovementioned is sufficient for a piece of paper 17½ by 15½ inches. Plaster of Paris gives a perfectly white surface; oxide of zinc, mixed with plaster of Paris, in the proportion of four parts of the former to three of the latter, gives a tint very near resembling ivory; precipitated carbonate of barytes gives a tint intermediate between the two.

The method of making ***Whity Brown Paper*** is the following; The constituent material consists in old worn-out sacks, which are first chopped into small pieces by a labourer, who is for that purpose furnished with a sharp chopper and a block; the fragments thus prepared are well washed by agitating them in a vat of water, changed as often as needful; after this they are cast into the mill, which consists of a longitudinally denticulated cylinder, or roller, not much unlike the crimping roller used by a laundress for crimping frills, &c.; this roller having a motion given it by a water wheel, revolves on its axis with great velocity, within the fixed concave section of a cylinder, likewise denticulated, and fitted so closely to it, but without contact, as to grind the shreds of sacking, which are now mixed with water to a fine pulp, as they are drawn in between the two surfaces. This part of the apparatus is contained in one side or division of a trough, of an oblong curvated form, with a partition in the middle, leaving it open at each end, thus forming a continuous canal in which the fluid moves round, the current which passes through the grinders being occasioned by the rapid revolution of the indented roller in the liquid. When the fibres have thus acquired a proper state of separation, the pulp is suffered to run out of the mill trough into a large receptacle, to await the next process. A sufficient portion is now transferred into another vat, where it is further diluted with water to a proper consistence, and moderately warmed by steam, circulated in pipes at the bottom of the vessel, and to prevent the pulp precipitating, the whole is kept in constant motion by an apparatus somewhat like a reel, revolving within at the lower part, and put in action also by a small water wheel. In this state, the colour, the consistency, and the ebullition, cause it to bear a striking resemblance to a huge mass of water gruel, "thick and slab." At this vessel stands a man furnished with a frame of wirework, very similar to what is used for meat safes, but of a closer texture, and not much unlike a four-sided shallow sieve, and of the size and form of the sheet of paper to be made; this he dips into the liquid, and on lifting it out the water drains through the wirework, and the frame is covered with a thin layer of the pulp; the frame is then inverted on a piece of flannel, when the pulp quits the frame, and lying on the flannel, resembles, and is in fact become, a sheet of wet paper: another flannel is laid on this for the next sheet, and so alternately, until the pile has accumulated to a certain quantity, when the whole is put into a powerful press, by which the water held in the material is expressed, and the paper thus brought to a state of comparative dryness. Each sheet is now taken from between the flannels, and hung across laths in the drying rooms: when dry, is made up into quires, again pressed, and packed up in reams for the consumer.

PAPER *Office*, an office in which all the public writings, matters of state and council, proclamations, letters, intelligences, negotiations abroad, and generally all despatches that pass through the office of the secretaries of state, are lodged by way of library.

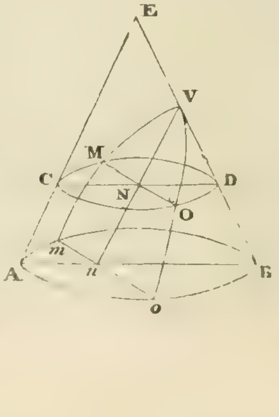
**PAPIER MACHE**, is a substance made of cuttings of white or brown paper, boiled in water, and beaten in a mortar till they are reduced into a kind of paste; and then boiled with a solution of gum arabic, or of size, to give tenacity to the paste, which is afterwards formed into different toys, &c. by pressing it into oiled moulds. When dry, it is covered with a mixture of size and lamp black, and afterwards varnished.

**PAPISTS**, persons professing the popish religion. By several statutes, if any English priest of the church of Rome, born in the dominions of the crown of England, come to England from beyond the seas, or tarried in England three days, without conforming to the church, he was guilty of high treason; and they also incurred the guilt of high treason who were reconciled to the see of Rome, or procured others to be reconciled to it. By these laws also, papists were disabled from giving their children any education in their own religion. If they educated their children at home, for maintaining the schoolmaster, if he did not repair to church, or was not allowed by the bishop of the diocese, they were liable to forfeit 10*l.* a month, and the schoolmaster was liable to the forfeiture of 40*s.* a day; if they sent their children for education abroad, they were liable to a forfeiture of 100*l.* and the children so sent were incapable of inheriting, purchasing, or enjoying any lands, profits, goods, debts, legacies, or sums of money: saying mass was punishable by forfeiture of 200 marks; and hearing it, by a forfeiture of 100*l.* But during the late reign the Roman Catholics have been in some measure relieved from many of the odious and unjust restrictions formerly imposed on them. See 18. Geo. III. c. 60; and 31 Geo. III. c. 22. Yet as the statute 1 William and Mary, st. 1, c. 18, called the Toleration Act, does not apply to Catholics, nor to persons denying the Trinity, they cannot serve in corporations, and are liable to the test and corporation act. They cannot sit in the house of commons, nor vote at elections, without taking the oath of supremacy, and cannot present to advowsons, although Jews and Quakers may. But the person is only disabled from presenting, and still continues patron. It seems they may serve on juries; but Catholic ministers are exempted. They also are entitled to attend the British factories and their meetings abroad, and may hold offices to be wholly exercised abroad, and may also serve under the East India Company. They are also enabled to hold any rank in the army, having been excused by a late statute from the oaths formerly required. In Ireland, papists may be justices of the peace, and are qualified to serve in corporations; but party spirit much prevailing, they are seldom elected.

**PAPYRUS**, a famous reed, or species of dog grass, from which was made the celebrated paper of Egypt.

**PAR**, in Commerce, signifies any two things equal in value.

**PARABOLA**, is one of the conic sections formed by the intersection of a plane and a cone, when the plane passes parallel to the side of the cone. This figure, like all other conic sections, may be treated of in three different ways, *viz.* 1. As being produced by the intersection of a plane and cone. 2. According to its description in plano. And, 3. As being generated by the motion of a variable line or ordinate, along another fixed line or directrix; in which case the properties of the curve are deduced from the equation by which it is defined or expressed. The vertex of a parabola is the point in which the cutting plane meets the side of the cone. Thus, V is the vertex of the parabola *m* V *o*. The axis is a straight line, V *n*, drawn from the vertex V, so as to divide the figure into two equal parts; and any line parallel to the axis is called a diameter. If a straight line, terminated by the curve, be bisected by the axis or by a diameter, it is called a double ordinate to the axis, or to that diameter, respectively; and its half is called an ordinate to it. The axis cuts its ordinates at right angles. Thus M N O is a double ordinate, and M N an ordinate to the axis V *n*. The segment of the axis, or of a diameter, between its vertex and ordinate, is called an absciss of the axis, or of that diameter. Thus V N is an absciss of the axis. A third proportional to the absciss, and its corresponding ordinate, is called the parameter, or latus rectum. The focus is that point in the axis where the absciss is equal to one-fourth of the parameter to the axis. The double ordinate, drawn through the focus, is called the parameter to the axis, or the principal latus rectum.



**PARACENTRIC** Motion, is the motion of a planet towards the centre of attraction, or the sun. The orbits of the planets being elliptical, they are sometimes nearer, and sometimes more remote, from the sun; and the difference in this distance is what is called the paracentric motion.

**PARADE**, in War, is a place where the troops meet to go upon guard, or any other service. In a garrison, where there are two, three, or more regiments, each have their parade appointed, where they are to meet upon all occasions, especially upon any alarm. And in a camp, all parties, convoys, and detachments, have a parading place appointed them at the head of some regiment.

**PARADISEA**, bird of Paradise; in Natural History, a genus of birds of the order Picæ, and they chiefly inhabit North Guinea, from which they migrate in the dry season into the neighbouring islands. They pass in flights of thirty or forty, headed by one whose flight is higher than that of the rest. They are often distressed by means of their long feathers, in sudden shiftings of the wind, and unable to proceed in their flight are easily taken by the natives, who also catch them with birdlime, and shoot them with blunted arrows. They are sold at Aroo for an iron nail each, and at Banda for half a rix dollar. Their food is not ascertained, and they cannot be kept alive in confinement. The smallest bird of paradise is supposed by Latham to be a mere variety of the above. It is found only in the Papuan islands, where it is caught by the natives often by the hand, and exenterated, and seared with a hot iron in the inside, and then put into the hollow of a bamboo, to secure its plumage from injury.

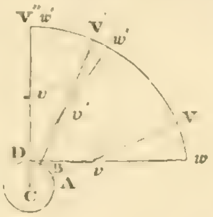
**PARADOX**, in Philosophy, a proposition seemingly absurd, as being contrary to some received opinion; but yet true in fact.

**PARAGRANDINE.** A new invention, whose object is to avert hail storms, as the electrical conductors serve to obviate danger from lightning. In this climate, the hail is seldom so violent as to occasion any very serious losses; but in many parts of the continent, it is dreaded as the most destructive enemy of the husbandman; and we have known insurance companies established for the sole purpose of guarding against loss by hail-storms. The inventor of the Paragrandine is a Signor Apostolla. One of the latest accounts of its beneficial effects, published by Signior Antonio Perotti of San Giovanni di Cassara, states, that having on a piece of land belonging to himself, containing 16,000 perches in extent, fixed up several of the Paragrandini, he had the satisfaction to find that no injury was done by hail to the corn, and very little to the vines, although no less than fourteen storms had occurred in the current year, five of which appeared to threaten great mischief to his fields, but passed over them, and fell on the neighbouring lands of Valvasoni, Baguarola, and Savorganno. These instruments are composed of metallic points and straw ropes, bound together with hempen or flaxen threads. Dr. Astolfi, in a letter to professor Francesco Orioli of Bologna, relates, that a hail storm proceeding in a direction from Bentivoglio to S. Giovanni Triano, came near the lands of Count Chenef, which were protected by Paragrandini; on approaching which the clouds were seen at once to disperse. A notice, contained in an official report to the Milan government by the Gonfalonieve of San Pietro in Casale, states, that during a stormy day, when there were many claps of thunder and flashes of lightning, he went out to observe the effects of the Paragrandine, and noticed the electric fluid to be attracted by the points of the straw in the machine, around which the flame played in graceful curves; while in the adjoining fields not protected by the Paragrandine, much rain fell, and the lightning did considerable mischief.

**PARAGUAY TEA.** A modern writer, giving a description the province of Buenos Ayres, (the population of which he estimates at 1,100,000,) says, the Paraguay tea is an article of the greatest importance all over that part of the continent. It is a plant which rises about 1½ feet high, with slender branches and leaves, something like those of senna. The herb is in general and almost universal use. It is infused, and made nearly the same way as China tea, excepting that the branches are put in along with the leaves, and that it is drunk out of the vessel that it is made in, through a silver and glass pipe, as soon as possible. The smell and colour of this drink is said to be equal to the Chinese teas. None of this tea had, in 1826, reached England, so that its merits must be taken on report. As our commerce, however, increases with the South American countries, some of this herb will naturally find its way into Britain, and if it should prove acceptable to the general taste, and become a rival to the China tea, it would be an important staple in the commerce of the two countries.

**PARALLATIC Angle**, is the angle subtended by two lines drawn from the centre of a planet, the one to the centre of the earth, and the other to the same point on its surface. *See* Parallax.

**PARALLAX**, in Astronomy, an arc of the heavens intercepted between the true and apparent place of any of the heavenly bodies; that is, between its place as viewed from the centre of the earth, and from some point on its surface. Thus, let A B C be the earth, C its centre, $v\,v'\,v''$ three different planets, or three different positions of the same planet; then its true places in these positions, as seen from the centre C, and as referred to the heavens, will be V V′ V″; but their apparent places will be $w$, $w'$, $w'$, and the arcs $w$ V, $w'$ V′, and V″ $w''$, will be the measures of the parallaxes, or of the parallactic angles V $v\,w$, $v'\,v'\,w'$, &c. or of D $v\,c$, D $v'$ C, &c. to which they are equal.



The *Horizontal* Parallax, or that which has place when the star is in the horizon, is the greatest; the angles and arcs both diminish from the horizon to the zenith, where it becomes nothing, as is obvious from the above figure. Whence it is obvious, that the parallax diminishes the apparent altitude of a body; but that this diminution is less and less, as the altitude becomes greater and greater; and it has, therefore, a contrary effect to refraction, which always increases the apparent height of any of the celestial objects. Parallax receives particular denominations, according to the circle upon which it is computed.

Parallax of *Altitude*, is the difference between the true and apparent altitude of a planet, as above described.

Parallax of *Right Ascension* and *Descension*, is an arch of the equinoctial, by which the parallax of altitude increases the ascension and diminishes the descension.

Parallax of *Declination*, is an arch of a circle of declination, by which the parallax of the altitude increases or diminishes the declination of a star.

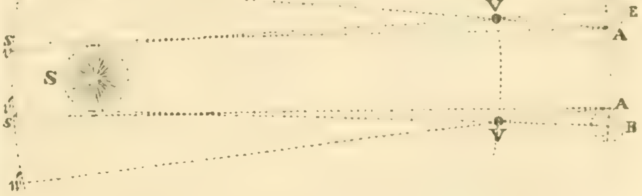
Parallax of *Latitude*, is an arch of a circle of latitude, by which the parallax of altitude increases or diminishes the latitude.

*Menstrual* Parallax of the *Sun*, is an angle formed by two right lines; one drawn from the earth to the sun, and another drawn from the sun to the moon, at either of their quadratures.

Parallax of the *Annual Orbit of the Earth*, is the difference between the heliocentric and geocentric place of a planet, or the angle at any planet subtended by the distance between the earth and sun.

Parallax of the *Planets*. The exact determination of the parallax of the planets is of the greatest importance in astronomy, as it is from that, or indeed from the parallax of any one of them, we estimate their several distances. For if the parallax, or the angle which is subtended by the terrestrial radius, at any planet be known, its distance from the earth is also known; whence its distance from the sun, as also the distances of all the other planets, will be known also, from the third law of Kepler, *viz.* that the squares of the periodic times are as the cubes of the distances. To illustrate this it may be observed, that in very small angles, as are those of the parallaxes, and while the side subtending those angles remains constant, the angles will be reciprocally as the distances; that is, if D C be very small with regard to C V, then the angle D V C : angle D M C :: C V : C M nearly. For in this case we may consider D V = C V and D M = C M, also D C will not differ sensibly from the arc of the circles which subtends the angles at V and M, and therefore putting 3·1416 = $p$ we have $\frac{\text{D C}}{2p \times \text{C V}}$ for the measure of the angles D V C, and $\frac{\text{D C}}{2p \times \text{C M}}$ for the measure of the angle D M C, which are therefore reciprocally as C V and C M. It is obvious, therefore, that the parallax of any one of the planets being found, that of all the others may be determined, because their proportional distances from the sun are accurately known from Kepler's law, above mentioned. There are many different methods of determining the parallax of the planets; but being an extremely delicate operation, on account of the smallness of the angles, we had several different results; till the parallax of Venus was determined by means of her transits over the sun's disc, in 1761 and 1769; and as it is on this, that a great part of our knowledge depends respecting the absolute distances of the planets from the sun, it will be proper to give a sketch of the principles on which it rests, without, however, attempting to enter into the minutiæ of the observations and calculations. Let V V′ represent the orbit of Venus, and E E′ that of the earth; V and E being the positions of these two bodies at the true time of Venus entering upon the disc of the sun, that is, to an observer situated at the earth's centre, by whom her place in the heavens would be referred to $v$, which would be also the place of the eastern limb of the sun. But to an observer situated at A, Venus would be referred in the heavens to $w$, and the eastern limb of the sun to $s$; and consequently, to such an observer, Venus, instead of appearing on the sun's disc, would be distant from him by the arc S W, that is, by an arc equivalent to the difference of the parallax of Venus and of the sun. And in the same manner, supposing the earth, during the transit, to have moved in its orbit from E to E′, and Venus from V to V′; it is obvious, from what is said above, that at the time when this planet was just quitting the sun's western limb, to an observer situated at the centre E, would be referred by an observer at A to $v'$, and the western limb of the sun at $s'$; so that, in the first case, she would not enter the sun's disc till after the true time, and in the latter, she will appear to leave the sun's disc before the true time; and as in some parts of the world, in the transit above alluded to, Venus was seen both to enter and emerge from the sun's limb by the same observer, the whole difference between the true and apparent time of the transit became known, and half this difference was the time Venus was in passing over the arc $w\,s$; whence the measure of that arc became known, or, which is the same, the difference between the parallax of Venus and that of the sun. But to those observers who could not see both the immersion and emersion, the difference between the true and apparent time of either, when converted into seconds of a degree, was what determined the difference of the parallax of the two bodies. Now this difference being known, as

*Parallax.*



also the proportional distances of the Earth, Venus, and the Sun, their absolute parallaxes were determined, this, as we have shewn above, being reciprocally as the distances. Let $m : n$ represent the ratio of the distance E $v$ to E S, also P and $p$ the parallaxes of Venus and the Sun, which are required, and $P - p = q$, the difference of their parallaxes as found above; then, $n : m :: P : p$, whence $n - m : m :: P - p = q : \frac{m\,q}{n - m} = p$, the sun's parallax. In this manner, aided by subsequent observations, &c. Laplace has determined the parallax of the sun to be $8''\frac{3}{4}$, whence its distance is found to be about 94 million miles. And hence the parallaxes of the several planets are determined as follows:—Greatest horizontal parallax of the Sun, 8″.75; Mercury, 14″.58; Venus, 29″.16; Mars, 17″.50; Jupiter, 2″.08; Saturn 1″027; Uranus, 0″415.

Parallax of the *Moon.* This is much more considerable than in any other of the heavenly bodies, on account of its proximity to the earth, and is much easier determined than any of the others; one of the most simple and correct methods being as follows:—Observe the moon's meridian altitude with the greatest accuracy, and mark the moment of observation: this time being equated, compute her true longitude and latitude, and from these find her declination; and from her declination, and the elevation of the equator, find her true meridian altitude; if the observed altitude be not meridian, reduce it to the true time for the time of observation; take the refraction from the observed altitude, and subtract the remainder from the true altitude, and the remainder is the moon's parallax: by this means the parallax of the moon has been found as follows, *viz.* Greatest parallax, 61′ 32″. Least parallax, 54′ 4″. Mean parallax, 57′ 48″. But Laplace makes her mean parallax 56′ 34″.2.

Parallax of the *Fixed Stars.* As the distances of the heavenly bodies are determined by means of their parallaxes, every possible method has been attempted to ascertain the parallax of some of the fixed stars, but their distance is so immense, that not only have they no parallax, as compared with the terrestrial radius, but even the whole diameter of the earth's orbit, though near 200 million miles, is not sufficient to render any difference in their apparent places at all evident, which, if it only amounted to one second, would be discoverable by modern instruments. This distance, therefore, great as it is, is not more than a mere point compared with the distance of the nearest of the fixed stars.

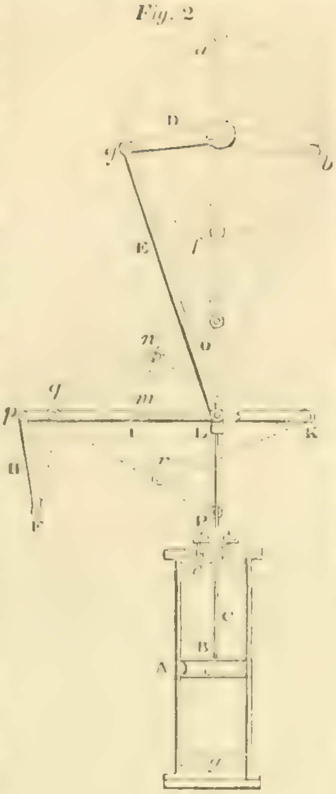
**PARALLEL** Motion, is a term used among practical mechanics to denote the rectilinear motion of a piston rod, &c. in the direction of its length; and contrivances by which such alternate rectilinear motions are converted into rotatory ones, and *vice versa,* in pumps, steam-engines, saw-mills, &c. are usually called contrivances for parallel motions. In motions of this kind it is generally thought a desirable thing to give the piston rod, the saw, or the like, a uniform velocity through the whole of its progress; then to bring it at once to rest, again to give it instantaneously a finite velocity in the opposite direction, and so on. But this seems impossible in nature; all changes of motion which we observe are gradual, because all impelling bodies have some elasticity or softness by which they yield to compression; and, in the way in which pistons are commonly moved, *viz.* by cranks, or something analogous to them, the motion is very sensibly gradual. Hence, it may be observed, that most attempts to correct these inequalities in motion are misplaced; and if they could be accomplished, would greatly injure the pump or other machine. One of the best methods of producing this effect is, to make the piston rod consist of two parallel bars, having teeth in the sides which front each other. Let a toothed wheel be placed between them, having only the half of its circumference furnished with teeth. It is evident, without any further description, that if this wheel be turned uniformly round its axis, the piston rod will be moved uniformly up and down without intermission. This has often been put in practice, and the piston rod made to work between grooved rollers; but the machine always went by jolts, and seldom lasted a few days. Unskilled mechanists attributed this to defect in the execution; but the fault is essential, and lies in the principle. The machine could not perform one stroke if the first mover did not slacken a little, or the different parts of the machine did not yield by bending, or by compression; and no strength of materials could withstand the violence of the strains at every reciprocation of the motion. This is chiefly experienced in great works which are put in motion by a water wheel, or some other equal power exerted on the mass of matter of which the machine consists. The water wheel being of great weight, moves with considerable steadiness or uniformity; and when an additional resistance is opposed to it by the beginning of a new stroke of the piston, its great quantity of motion is but little effected by this addition, and it proceeds very little retarded; and the machine must either yield a little by bending and compression, or go to pieces, which is the common event. Cranks are free from this inconvenience, because they accelerate the piston gradually, and bring it gradually to rest, while the water wheel moves round with almost perfect uniformity. The only inconvenience (and it may be considerable) attending this slow motion of a piston at the beginning of its stroke is, that the valves do not shut with rapidity, so that some water gets back through them. But when they are properly formed and loaded, this is but trifling. It would seem, then, that those contrivances in which the piston rod communicates the rotatory motion by means of a crank, or something similar in its effect, are most fit to be adopted in practice; and that the attempts of mechanists in this point of view may, in all probability, be properly restrained to the methods of keeping the piston rod, &c. from deviating to any side, during its alternate motion. Two or three of the best methods of performing this, with which we are acquainted, are the following:—

1. Let a fixed circular ring, whose diameter is equal to the stroke of the piston, have teeth all round the interior parts of its circumference; and let a smaller wheel, whose diameter is only half that of the ring, have equal teeth on the exterior part of its rim, to play into the teeth of the ring; let the axis of the wheel, to which the rotatory motion is to be communicated, pass through the centre of the larger ring; and let a moveable bar join the centre of this ring to that of the smaller wheel. Then, if the upper extremity of the piston rod be attached to a pin fixed on the rim of the inner wheel, at the place where the two wheels are in contact in their lowest point, and the rod be put into motion, it will cause the small wheel to revolve upon the inner part of the fixed ring, and by this means give the proposed rotatory motion to the axis passing through the centre of the ring. At the same time, the extremity of the piston rod will be confined to move in the vertical diameter of the ring; because it is made to describe an epicycloid of that kind, which is formed by a circle rolling along the inside of another circle of double diameter; in which case, it is well known, the epicycloid becomes a diameter of the larger circle, and the smaller circle makes two complete revolutions, while it is moving from any one point of the larger circle to the same point again. This contrivance was devised, we believe, by Mr. White, an Anglo-American. It is almost unnecessary to observe, that the converse is equally applicable in the conversion of a rotatory into a parallel motion.

2. Another method is represented in fig. 2, where the piston rod is kept from deviation. A is the cylinder, B the piston, C the piston rod, D the crank, and E the connecting rod of the crank and piston rod. When the piston is at $e$, the crank is at $a$; when the piston is at B, the crank is either at $g$ or $b$; and when the piston is at $g$, the crank is at $f$; so that when the motion of the crank is uniform, that of the piston is variable. The rod H, equal in length to the crank D, moves about the centre F, and is joined to one end of the rod I; to the other end of which is connected the socket L, that receives the top end of the piston rod. A certain point $m$ is taken at pleasure in the rod I, to carry a short axle for the rods K, which are broken in the figure to shew the socket L. To find the centre of motion of the rods K, move the end L of the rod I up and down in the vertical line $c\,f\,a$, and mark three positions $n, m, r$, of the point $m$ on that rod; describe a circle to pass through those three points; its radius will be equal to the length of the rods K, and its centre will be the point where those rods must be fixed to a bolt or axle in the framing. This contrivance causes the top of the piston rod to move from P by L to O, and back

again by L to p; and the dotted lines shew the position of the several rods at the extremities of the motion. In fig. 3, we have given a horizontal section, to shew the connexion of H, I, K, &c. pointing out in what way I grasps L, and E both. The inequality of the piston's motion will be reduced by making the connecting rod E as long as circumstances will permit. If the rod I were extended to the left of the point p, the same kind of apparatus would become a lever with a moveable fulcrum, by means of which a weight might be raised in a vertical line from P to O; or a pump piston rod worked without deviation.

*Fig.* 2



This construction is described in a prismatic form, by Professor Playfair, in his Outlines of Nat. Philosophy, vol. i. art. 355.

3. A third method is exhibited in fig. 1, where are three rods A, B, and C, besides the connecting rod D. The rods A and C are of equal lengths, and the connecting rod is attached to the middle point of the rod B. The guides A, and C, are fixed at their ends E and F, by bolts to the framing. Thus the point B, to which is fixed the top of the piston rod, is made to move in the right line $bBb'$; and the dotted lines shew the positions of the rods at the extremities of the stroke. This method, and the preceding, were devised by Mr. William Dryden, a mechanic whose ingenuity needs not our encomium.

*Fig.* 3.

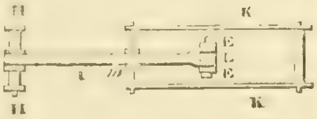
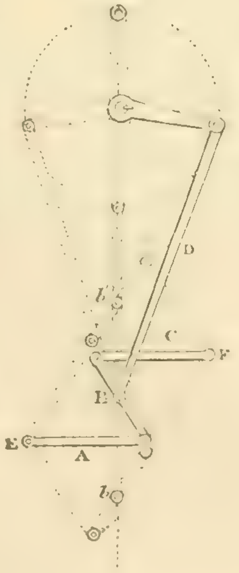
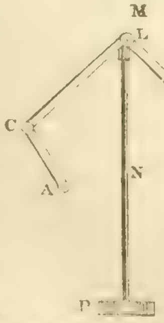


*Fig.* 1.



4. Another method is shewn in fig. 4. A and B are two bolts in the framing at equal distances on opposite sides of the vertical line in which the piston is to move. A C, B D, two bars of equal length, each equal to about half the distance A B. CL, DL, two other equal bars, rather more than double the length of the former, moving freely on joints at C and D. At L is a socket, as in figure 2 to receive the top of the piston rod, and to which the bars C L, D L, and the connecting rod E, are attached. By this contrivance it is obvious, that as the rods B C, B D, turn upon the centres A, B, in contrary directions, the piston rod will be made to move in the right line P M without deviation; N M being the length of the stroke. The relative lengths of the bars A C, C L, may be varied at pleasure; but those we have mentioned will be found as well as any in practice.

*Fig.* 4.

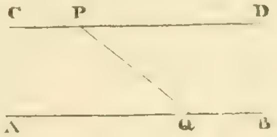


5. A piston rod may also be kept from deviating to either side, while it gives motion to a crank, and *vice versa*, thus: place a cross bar at a distance from the end of the cylinder, rather greater than the stroke of the piston, and make the piston rod play in a hole made in the cross bar; let an axle be fixed to a proper point of the piston rod between the end of the cylinder and the cross bar, and from this axle let two equal connecting rods pass to the crank, one on each side the cross bar: by this simple contrivance, the alternating and circular motions may be communicated to the different parts of the machine with great facility.

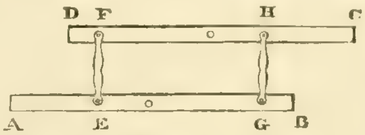
6. A rectilinear vertical motion may, again, be produced thus:—Two of the adjacent angles of a parallelogram are made to describe concentric circles, so that the side between them passes through their centre, and one of the remaining angles another circle having its convexity opposed to that of the two former, then the fourth angle of the parallelogram will describe a line that differs insensibly from a straight line. This construction is the invention of Watt, and now very common.—*Gregory's Mechanics.*

PARALLEL, in Geometry, is applied to lines, figures, and bodies, which are every where equidistant from each other, or which, if ever so far produced, would never meet.

PARALLEL *Right Lines*, are those which, though infinitely produced, would never meet; which is Euclid's definition. To draw a line C D parallel to a given line A B through a given point P. From P draw any line meeting A B in some point Q; then make the angle Q P D = the angle A Q P, so shall D P C be the parallel line required. This in practice is better done by a parallel ruler.



PARALLEL *Ruler*, an instrument consisting of two wooden, brass or steel rulers, A B and C D, equally broad throughout, and so joined together by the cross blades E F and G H, as to open to different intervals, and accede and recede, yet still retain their parallelism. The use of this instrument is obvious; for one of the rulers being applied to a given line, another drawn along the extreme edge of the other, will be parallel to it; and thus, having given only one line, and erected a perpendicular upon it, we may draw any number of parallel lines or perpendiculars to them, by only observing to set off the exact distance of every line with the point of the compasses. But the best parallel rulers are those whose bars cross each other, and turn on a joint at their intersection; one of each bar moving on a centre, and the other ends sliding in grooves as the rulers recede.



PARALLELS *of Latitude*, in Astronomy, are lesser circles of the sphere parallel to the ecliptic, imagined to pass through every degree and minute of the colures.

PARALLELS *of Altitude*. Almucanters, are circles parallel to the horizon, imagined to pass through every degree and minute of the meridian between the horizon and zenith, having their poles in the zenith. They are represented on the globe by the division on the quadrant of altitude, in its motion about the body of the globe, when screwed to the zenith.

PARALLELS *of Declination*, in Astronomy, are the same with parallels of latitude in Geography.

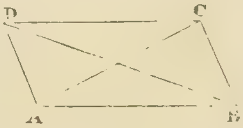
PARALLEL *Sphere*, that situation of the sphere wherein the equator coincides with the horizon, and the poles with the zenith and nadir. In this sphere all the parallels of the equator become parallels of the horizon, consequently no stars ever rise or set, but all turn round in circles parallel to the horizon; and the sun, when in the equinoctial, wheels round the horizon the whole day. After his rising at the elevated pole, he never sets for six months; and after his entering again on the other side of the line, never rises for six months longer.

**Parallel** *Sailing*, in Navigation, is the sailing under a parallel of latitude. *See* Navigation.

**PARALLELISM** of the *Earth's Axis*, is used to denote that invariable position of the terrestrial axis, by which it always points to the same point in the heavens, abstracting from the trifling effect of nutation, &c. *See* Nutation.

**PARALLELOGRAM**, in Geometry, is a quadilateral right-lined figure, whose opposite sides are parallel.

**Parallelogram** receives particular denominations, according to the equality or inequality of its sides and angles. Thus, a *rectangle*, *rhombus*, *rhomboid*, and *square*, are each a particular species of parallelograms, for the properties of which see the several articles. Other properties, common to every parallelogram, may be enumerated as follows:—1. A parallelogram has its opposite sides and angles equal to each other, and the diagonal divides it into two equal triangles. 2. The two adjacent angles of any parallelogram are, together, equal to two right angles. 3. Parallelograms having equal bases and altitudes, are equal; on equal bases they are to each other as their altitudes; and with equal altitudes they are to each other as their bases; and generally parallelograms are to each other in the compound ratio of their bases and altitudes. 4. The sum of the squares of the diagonals of any parallelogram, is equal to the sum of the squares of the four sides. 5. The complements about the diagonals of any parallelogram are equal to each other.



**Parallelogram** of *Forces*, is a term used to denote the composition of forces, or the finding a single force that shall be equivalent to two or more given forces when acting in given directions.

**PARALLELOPIPED**, in Geometry, a regular solid, comprehended under six sides, or parallelograms, the opposite ones of which are similar, parallel, and equal to each other.

**PARALLOGISM**, in Logic, a false reasoning, or a fault committed in demonstration, when a consequence is drawn from principles that are false; or, though true, are not proved; or when a proposition is passed over that should have been proved by the way.

**PARAMETER**, a certain and constant right line in each of the three conic sections, and otherwise called the *Latus Rectum*.

**PARAMOUNT**, the supreme or highest lord of the fee.

**PARAPET**, in Fortification, an elevation of earth designed for covering the soldiers from the enemy's cannon or small shot.

**PARAPHERNALIA**, are the women's apparel, jewels, and other things, which in the life-time of her husband she wore as the ornaments of her person, to be allowed by the discretion of the court, according to the quality of her and her husband. The husband cannot devise such ornaments and jewels of his wife, though during his life he has power to dispose of them. But if she continues in the use of them till his death, she shall afterwards retain them against his executors and administrators, legatees, and all other persons, except creditors where there is a deficiency of assets. 2 Black. 436.

**PARAPHRASE**, an explanation of some text, in clearer and more ample terms, whereby is supplied what the author might have said or thought on the subject; such are esteemed Erasmus's Paraphrase on the New Testament, the Chaldee Paraphrase on the Pentateuch, &c.

**PARASANG**, an ancient Persian measure, different at different times, and in different places; being sometimes 30, sometimes 40, and sometimes 50 stadia or furlongs.

**PARASELINE**, a mock moon, seen usually in a ring surrounding the moon.

**PARASITES**, or **Parasitical** *Plants*, in Botany, such plants as are produced out of the trunk or branches of other plants, from whence they receive their nourishment, and will not grow upon the ground; as the mistletoe, &c.

**PARBUCKLE**, is a contrivance to haul up or lower down a cask, &c. where there is no crane or tackle; it is formed by passing the middle of a rope round a post or ring, or under a boat's thwart; the two parts of the rope are then passed under the two quarters of the cask, bringing the two ends back again over it, which being both hauled or slackened together, either raise or lower the barrel, &c. as may be required.

**PARCELLING**, long narrow slips of canvass, and frequently bound about a rope in the manner of bandages, previous to its being served. It is laid in spiral twines as smoothly upon the surface as possible, that the rope may not become uneven and full of ridges. Parcelling is also used to raise a mouse on the stays, &c. and is firmly fastened by marline from one end to the other. *Parcelling a Seam*, is the laying a slip of canvass upon it, and daubing it over with melted pitch.

**PARCEL MAKERS**, two officers in the exchequer, who make parcels of the escheators' accounts, in which they charge them with every thing they have levied for the king's use, within the time of their office, and deliver the same to one of the auditors of the court to make their accounts therewith.

**PARCHMENT**, is the skin of sheep or goats, prepared for writing, and covering books. The skin is stripped of its wool, and passed through the lime pit. The skinner then stretches it on a frame, perforated longitudinally with holes furnished with wooden pins that may be turned at pleasure, like those of a violin, to stretch the skin like a drum head. The skin being thus sufficiently stretched on the frame, the flesh is pared off with a sharp instrument; it is then moistened with a rag, and white chalk reduced to a fine dust, strewed over it; then with a large pumice stone, the workman rubs over the skin, and thus scours off the remains of the flesh. They then go over it again with an iron instrument; moisten it as before, and rub underneath with pumice stone without any chalk; this smooths and softens the flesh side very considerably. They drain it again, by passing over it the iron instrument as before. The flesh side thus drained, they pass the iron on the hair side; then stretch it tight on the frame by means of the pins, and go over the flesh side again with the iron; this finishes its draining: the more the skin is drained, the whiter it becomes. They now throw on more chalk, sweeping it over with a piece of lamb skin that has the wool on; this smooths it further, and gives it a white knap. When dried, it is taken off the frame, by cutting all round. The skin, thus far prepared by the skinner, is taken by the parchment-maker; who first scrapes or pares it dry on the summer, which is a calfskin stretched in a frame, with an iron instrument like that above named, only finer and sharper; with this, worked with the arm from the top to the bottom of the skin, he takes away one-half of its thickness, and the skin thus equally pared on both sides, is rubbed with the pumice stone to smooth it. This last preparation is performed on a bench covered with a sack stuffed with flocks, and it leaves the parchment fit for writing upon.

**Vellum**, made from the skins of sucking calves, possesses a finer grain than parchment, but it is prepared in the same manner, without however being passed through alum water.

**PARDIES, Ignatius Gaston**, an ingenious French mathematician, was born in the province of Gascony, in 1636, and died in 1673, when only 37 years of age.

**PARDON**, in a religious sense, is an exercise of the divine placability towards repentant offenders. It is nearly the same as grace and favour, and is conferred on those who comply with the terms or conditions of the gospel, which are faith, repentance, and future obedience. It is a result of the sovereignty of Almighty God; and is therefore given without any consideration of reward, satisfaction, or advantage to the offended.

**Pardon**, in a legal sense, is the remitting or forgiving a felony, or other offence committed against the king. Blackstone mentions the power of pardoning offences to be one of the greatest advantages of monarchy in general, above every other form of government; and which cannot subsist in democracies. Its utility and necessity are defended by him on all those principles which do honour to him and human nature. See 4 Black. 496. Pardons are either general or special: general, as by act of parliament, of which, if they are without exceptions, the court must take notice *ex officio;* but if there are exceptions therein, the party must aver that he is none of the persons excepted. 3 Inst. 233 Special pardons are either of course, as to persons convicted of manslaughter, or *se defendendo*, and by several statutes to those who shall discover their accomplices in several felonies; or of grace, which are by the king's charter, of which the court cannot take notice *ex officio*, but they must be pleaded. 3 Inst. 283.

A pardon may be conditional, that is, the king may extend his mercy upon what terms he pleases; and may annex to his bounty a condition either precedent or subsequent, on the performance whereof the validity of the pardon will depend, and this by the common law. 2 Hawk. 37.

**PARENT, Anthony**, a reputable French mathematician, was born in Paris in 1666, and died in 1716, having at his death numerous manuscripts on various mathematical and philosophical subjects.

**PARENTS and CHILDREN.** If parents run away and leave their children at the charge of the parish, the churchwardens and overseers by order of the justices may seize the rents, goods, and chattels, of such parents, and dispose thereof towards their children's maintenance. A parent may lawfully correct his child, being under age, in a reasonable manner; but the legal power of the father over the persons of his children ceases at the age of 21. 1 Black. 452. *See* Infant.

**PARENTHESIS**, in Grammar, certain intercalary words inserted in a discourse, which interrupt the sense or thread, but seem necessary for the better understanding, of the subject.

**PARHELION**, a mock sun, or meteor of a bright colour, appearing on one side of the sun. Parhelia are more rarely seen than halos, but their appearance is singularly curious. Their apparent size is generally the same as the true sun; but they are not always round, nor always so bright as the sun; and when several appear, some are brighter than others. They are tinged externally with colours like the rainbow; and many of them have a long fiery tail, opposite to the sun, becoming paler towards the extremity. These tails mostly appear in a white horizontal circle, commonly passing through all the parhelia, and would go through the centre of the sun if it were entire. We have on record an account of parhelia seen at Rome, in March, 1629: at this time four were observed, one of which was very much tinged with various colours like the rainbow; and the others were faintly so. Some were also observed by Cassini, in 1683. In England and Scotland two have frequently been seen at a time. In North America they are often seen, and continue four hours, nay, sometimes for several days, being visible from sun-rise, to sun-set; when these disappear, rain or snow is there generally expected. Mr. Huygens, on applying his attention to these appearances, was soon sensible that they could not arise from such globules as formed the halos; yet since parhelia are always attended with halos, he was satisfied that their causes must be much alike. Considering, then, what other figures hail-stones might possibly have, besides a spherical one, he could find no other so simple as that of a cylinder; and, indeed, he had often observed, that snow consisted of several slender oblong particles, mixed with those of other shapes; and seeing that small globules were sufficient for the production of halos, he imagined that a great number of small cylinders, floating in the air, might produce similar appearances. He also remembered that Descartes had taken notice of several small columns, which he had seen lying on the ground, the extremities of which were bounded with flat star-like figures, consisting of six rays. The large white horizontal circle, observed in some of these phenomena, M. Huygens supposed to be produced by the reflection of the sun's rays from the outsides of the upright cylinders; since, when the sun shines upon a number of such cylinders suspended in the air, a white circle must necessarily appear to pass through the sun parallel to the horizon. This he shews very distinctly by a large figure of a cylinder, and by pointing out the progress of the sun's rays reflected from it. For every point of the sun's vertical diameter, as well as his centre, will illuminate a circle of cylinders, of the same apparent height as the illuminating point:—It is observable that no thick clouds are seen in the air when these circles appear; but only such as are very thin, and scarcely visible. For in most of these observations the sky is said to have been very clear and serene; which agrees quite well with this hypothesis; since these minute cylinders must constitute a very thin cloud uniformly extended, through which the sun, and even the colour of the sky, may be seen. *See* Halos.

**PARIS**, *Herb Paris*, or *Truelove*, a genus of plants belonging to the octandria class, and in the natural method ranking under the eleventh order sarmentaæ.

**Paris**, *Plaster of*, is burnt alabaster, which absorbs water so rapidly that in a few minutes it dries and becomes hard, so that it is greatly employed in making casts for figures, and in ornamental work among plasterers.

**PARISH.** In England there are 9913 parishes, of which 3845 are churches impropriate, and the rest are annexed to colleges or church dignities. In many of these parishes, on account of their large extent, and the number of parishioners, there are several chapels of ease. Parish signifies the precinct of a parish church, and the particular charge of a secular priest. Formerly a parish was synonymous with diocese, and the tithes were paid to any priest whom the party chose; but it was found convenient to allot a certain district for each priest, that he alone might receive the tithe. It is very doubtful when they originated. Some place the division of parishes in A.D. 650, others in 1179. A parish may contain one or more vills, but it is presumed to contain only one, and anciently was co-extensive with the manor. Money given by will to a parish is given to the poor. Sometimes by act of parliament a large parish is subdivided into two or more.

The extent of parishes is very different in different parts of England. In the northern counties some parishes contain from twelve to twenty cures of souls, each of the extent of a parish in the southern counties. This is supposed to have arisen from the scanty population at the time of the first division.

**PARISH CLERK.** In every parish, the parson, vicar, &c. has a parish-clerk under him, who is the lowest officer of the church. These were formerly clerks in orders, and their business at first was to officiate at the altar, for which they had a competent maintenance by offerings, but now they are almost always laymen, and have certain fees with the parson on christenings, marriages, burials, &c. besides wages for their maintenance. He must be twenty years of age, and of honest conversation, and is generally appointed by the minister, unless there is a custom for the churchwardens and parishioners to elect. It is an office for life, and a freehold. He may make a deputy without license of the bishop.

**PARISHIONER**, an inhabitant of or belonging to any parish, lawfully settled there. Parishioners are a body politic to many purposes: as, to vote at a vestry if they pay scot and lot, and they have a sole right to raise taxes for their own relief, without the interposition of any superior court; may make bylaws to mend the highways, and to make banks to keep out the sea, and for repairing the church, and making a bridge; and for making and maintaining fire engines. They may also purchase workhouses for the poor, or any such thing for the public good.

**PARISH-OFFICERS**, officers chosen annually to regulate and manage the concerns of the parish.

**PARK**, a piece of ground enclosed and stored with wild beasts of chase, which a man may have by prescription or the king's grant. By 16 Geo. III. c 30, if any person shall pull down or destroy the pale or wall of a park, he shall forfeit 30*l*.

**PARLIAMENTS, or General Councils**, in some shape, are of as high antiquity as the Saxon government in this island, and coeval with the kingdom itself. Blackstone, in his valuable Commentaries, says, "It is generally agreed, that in the main, the constitution of parliament, as it now stands, was marked out so long ago as the 17th of king John, A. D. 1215, in the Great Charter granted by that prince; wherein he promises to summon all archbishops, bishops, abbots, lords, and greater barons, personally, and all other tenants in chief, under the crown, by the sheriff and bailiffs, to meet at a certain place, within 40 days' notice, to assess aids and scutages when necessary. And this constitution hath subsisted, in fact, at least from the year 1266, 49 Henry III. there being still extant writs of that date to summon knights, citizens, and burgesses, to parliament." The parliament is assembled by the king's writs, and its sitting must not be intermitted above three years. Its constituent parts are, the king sitting there in his royal political capacity, and the three estates of the realm; the lords spiritual, the lords temporal (who sit together with the king in one house,) and the commons, who sit by themselves in another. The king and these three estates, together, form the great corporation or body politic of the kingdom, of which the king is said to be *caput principium et finis*. For upon their coming together, the king meets them, either in person, or by representation; without which there can be no beginning of a parliament; and he also has alone the power of dissolving them. It is highly necessary for preserving the balance of the constitution, that the executive power should be a branch, though not the whole, of the legislature. The crown cannot begin of itself any alterations in the present established law; but it may approve or disapprove of the alterations suggested and consented to by the two houses. The legislative therefore cannot abridge the executive power of any rights which it now has by law, without its own consent: since the law must perpetually stand as it now does, unless all the powers will agree to alter it. And herein indeed consists the true excellence of the English government, that all the parts of it form a mutual check upon each other. In the legislature, the people are a check upon the nobility, and the nobility a check upon the people; by the mutual privilege of rejecting what the other has resolved: while the king is a check upon both, which preserves the executive power from encroachments.

The lords spiritual consist of two archbishops and twenty-four bishops. The lords temporal consist of all the peers of the realm, the bishops not being in strictness held to be such, but merely lords of parliament. Some of the peers sit by descent; some by creation: others, since the union with Scotland, by election, which is the case of the sixteen peers, who represent the body of the Scots nobility. The peers for Ireland, at present, are 28, but the number is indefinite, and may be increased at will by the power of the crown.

A body of nobility is more peculiarly necessary in our mixed and compounded constitution, in order to support the rights of both the crown and the people; by forming a barrier to withstand the encroachments of both. It creates and preserves that gradual scale of dignity, which proceeds from the peasant to the prince; rising like a pyramid from a broad foundation, and diminishing to a point as it rises. The nobility therefore are the pillars, which are reared from among the people, more immediately to support the throne; and if that falls, they must also be buried under its ruins. Accordingly, when in the 17th century the commons had determined to extirpate monarchy, they also voted the house of lords to be useless and dangerous.

The commons consist of all such men of any property in the kingdom, as have not seats in the house of lords; every one of which has a voice in parliament, either personally, or by his representatives. This, however, must be understood with some limitation. Those who are possessed of land estates, though to the value of only 40*s.* per annum, have a right to vote for members of parliament; as have most of the members of corporations, boroughs, &c. But there are very large trading towns, and populous places, which send no members to parliament; and of those towns which do send members, great numbers of the inhabitants have no votes. Many thousand persons, of great personal property, have, therefore, no representatives. Indeed, the inequality and defectiveness of the representation has been justly considered as one of the greatest imperfections in the English constitution. The extension of parliaments to seven years, has also been viewed in the same light.

The house of commons, in the reign of Henry VI. consisted of 300 members. In Sir E. Coke's time they amounted to 493. In 1707, they were augmented to 513, for England and Wales; but the union with Scotland taking place in the above year, forty-five representatives were added for that country. In 1801, when the union with Ireland was effected, an additional 100 was introduced, so that the whole house of commons now consists of 658 members; *viz.* 80 knights for 40 counties in England; 50 citizens for 25 cities, (Ely sending none, and London four,); 334 burgesses for 167 boroughs, and five burgesses for five boroughs, *viz.* Abingdon, Banbury, Bewdley, Higham Ferrers, and Monmouth; four burgesses for the two universities of Oxford and Cambridge; 16 barons for the eight cinque ports, *viz.* Hastings, Dover, Sandwich, Romney, Hythe, and their three branches, Rye, Winchelsea, and Seaford; 12 knights for 12 counties in Wales; 12 burgesses for 12 boroughs in that country; 30 knights for the shires of Scotland, and 15 burgesses for its boroughs; 64 knights and 36 burgesses for Ireland. Every member, though chosen by one particular district, when elected and returned, serves for the whole realm. For the end of his coming thither is not particular, but general; not merely to serve his constituents, but also the commonwealth, and to advise his majesty, as appears from the writ of summons.--To prevent bribery, the following oath is provided to be administered to every voter prior to his being polled:—"I, ——— ———, do swear (or being one of the people called Quakers, do solemnly affirm,) I have not received or had, by myself, or any person whatsoever in trust for me, or for my use and benefit, directly or indirectly, any sum or sums of money, office, place or employment, gift or reward, or any promise or security for any money, office, or employment, or gift, in order to give my vote at this election: and that I have not before been polled at this election. So help me God."

These are the constituent parts of a parliament; the king, the lords spiritual and temporal, and the commons. Parts, of which each is so necessary, that the consent of all three is required to make any new law that should bind the subject. Whatever is enacted for law for one, or by two only, of the three, is no statute; and to it no regard is due, unless in matters relating to their own privileges. The power and jurisdiction of parliament, says Edward Coke, is so transcendent and absolute, that it cannot be confined, either for causes or persons, within any bounds. It hath sovereign and uncontrollable authority in making, confirming, enlarging, restraining, abrogating, repealing, reviving, and expounding of laws, concerning matters of all possible denominations, ecclesiastical, or temporal, civil, military, maritime, or criminal: this being the place where that absolute despotic power, which must in all governments reside somewhere, is entrusted by the constitution of these kingdoms. All mischiefs and grievances, operations and remedies, that transcend the ordinary course of the laws, are within the reach of this extraordinary tribunal. It can regulate or new model the succession to the crown; as was done in the reign of Henry VIII. and William III. It can alter the established religion of the land; as was done in a variety of instances, in the reign of king Henry VIII. and his three children, Edward VI., Mary, and Elizabeth. It can change and create afresh even the constitution of the kingdom, and of parliaments themselves; as was done by the act of union, and the several statutes for triennial and septennial elections. It can, in short, do every thing that is not naturally impossible; and therefore some have not scrupled to call its power by a figure rather too bold, the *omnipotence of parliament.* But then their power, however great, was given them in trust, and therefore ought to be employed according to the rules of justice, and for the promotion of the general welfare of the people. And it is a matter most essential to the liberties of the kingdom, that such members be delegated to this important trust, as are most eminent for their probity, their fortitude, and their knowledge; for it was a known apophthegm of the great lord treasurer Burleigh, "that England could never be ruined but by a parliament:" and, as Sir Mathew Hale observes, this being the highest and greatest court, over which none other can have jurisdiction in the kingdom, if by any means a misgovernment should any way fall upon it, the subjects of this kingdom are left without all manner of legal remedy. In order to prevent the mischiefs that might arise, by placing this extensive authority in hands that are either incapable, or else improper, to manage it, it is provided, that no one shall sit or vote in either house of parliament, unless he be twenty-one years of age. To prevent innovations in religion and government, it is enacted, that no member shall vote or sit in either house, till he hath, in the presence of the house, taken the oaths of allegiance, supremacy, and abjuration; and subscribed and repeated the declaration against transubstantiation, the invocation of saints, and the sacrifice of the mass. It is also enacted, that no alien, born out of the dominions of the crown of Great Britain, even though he be naturalized, shall be capable of being a member of either house of parliament.

Some of the most important privileges of the members of either house are, privilege of speech, of person, of their domestics, and of their lands and goods. As to the first, privilege of speech, it is declared by the statute of 1 William and Mary, st. 2. c. 2. as one of the liberties of the people, "that the freedom of speech, and debates, and proceedings in parliament, ought not to be impeached or questioned in any court or place out of parliament." And this freedom of speech is particularly demanded of the king in person, by the speaker of the house of commons, at the opening of every new parliament. So are the other privileges, of person, servants, lands, and goods. This includes not only privilege from illegal violence, but also from legal arrests, and seizures by process from the courts of law. To assault by violence a member of either house, or his menial servants, is a high contempt of parliament, and there punished with the utmost severity. Neither can any member of either house be arrested and taken into custody, nor served with any process of the courts of law; nor can his menial servants be arrested; nor can any entry be made on his lands; nor can his goods be distrained or seized, without a breach of the privilege of parliament. This exemption, however, from arrests for lawful debts, was always considered by the public as a grievance. The lords and commons therefore generously relinquished their privilege by act of parliament in 1770; and members of both houses may now be sued like other debtors.

The house of lords have a right to be attended, and consequently are, by the judges of the courts of king's bench and common pleas, and such of the barons of the exchequer as are of the degree of the coif, or have been made sergeants at law; as likewise by the masters of the court of chancery; for their advice in point of law, and for the greater dignity of their proceedings. The speaker of the house of lords is generally the lord chancellor, or lord keeper of the great seal, which dignities are commonly vested in the same person. Each peer has a right, by leave of the house as being his own representative, when a vote passes contrary to his sentiments, to enter his dissent on the journals of the house, with the reasons for such dissent; which is usually styled his protest. Upon particular occasions, however, these protests have been so bold as to give offence to the majority of the house, and have therefore been expunged from their journals: but this has always been thought a violent measure, and not very consistent with the general right of protesting.

The house of commons may be properly styled the grand inquest of Great Britain, impowered to inquire into all national grievances, in order to see them redressed. The peculiar laws and customs of the house of commons relate principally to the raising of taxes, and the elections of its members.

With regard to taxes: it is the ancient indisputable privilege and right of the house of commons, that all grants of subsidies, or parliamentary aids, do begin in their house, and are first bestowed by them: although their grants are not effectual to all intents and purposes, until they have the assent of the other two branches of the legislature. The general reason given for this exclusive privilege of the house of commons is, that the supplies are raised upon the body of the people, and therefore it is proper that they alone should have the right of taxing themselves. And so reasonably jealous are the commons of this privilege, that herein they will not suffer the other house to exert any power but that of rejecting; they will not permit the least alteration or amendment to be made by the lords to the mode of taxing the people by a money bill. Under this appellation are included all bills by which money is directed to be raised upon the subject, for any purpose, or in any shape whatsoever; either for the exigencies of government, and collected from the kingdom in general, as the land-tax; or for private benefit, and collected in any particular district, as by turnpikes, parish-rates, and the like.

The method of making laws is much the same in both houses. In each house the act of the majority binds the whole: and this majority is declared by votes openly and publicly given; not as at Venice, and many other senatorial assemblies, privately or by ballot. This latter method may be serviceable, to prevent intrigues and unconstitutional combinations, but is impracticable where a member's conduct must be open to the inspection of his constituents.

To bring a bill into the house of commons, if the relief sought by it is of a private nature, it is first necessary to prefer a petition; which must be presented by a member, and usually sets forth the grievance desired to be remedied. This petition (when founded on facts that may be in their nature disputed) is referred to a committee of members, who examine the matter alleged, and accordingly report it to the house; and then (or, otherwise, upon the mere petition) leave is given to bring in the bill. In public matters, the bill is brought in upon motion made to the house, without any petition. (In the house of lords, if the bill begins there, it is, when of a private nature, referred to two of the judges, to examine and report the state of the facts alleged, to see that all necessary parties consent, and to settle all points of technical propriety.) This is read a first time, and, at a convenient distance, a second time; and after each reading, the speaker opens to the house the substance of the bill, and puts the question, whether it shall proceed any farther. The introduction of the bill may be originally opposed, as the bill itself may at either of the readings; and if the opposition succeeds, the bill must be dropt for that session; as it must also, if opposed with success in any of the subsequent stages. After the second reading, it is committed, that is, referred to a committee; which is either selected by the house in matters of small importance, or else, if the bill is a matter of great or national consequence, the house resolves itself into a committee of the whole house. A committee of the whole house is composed of every member; and, to form it, the speaker quits the chair (another member being appointed chairman), and may sit and debate as a private member. In these committees, the bill is debated clause by clause, amendments made, the blanks filled up, and sometimes the bill entirely new-modelled. After it has gone through the committee, the chairman reports it to the house, with such amendments as the committee have made; and then the house re-consider the whole bill again, and the question is repeatedly put upon every clause and amendment. When the house have agreed or disagreed to the amendments of the committee, and sometimes added new amendments of their own, the bill is then ordered to be engrossed, or written in a strong gross hand, on one or more long rolls of parchment sewed together. When this is finished, it is read a third time, and amendments are sometimes then made to it; and, if a new clause be added, it is done by tacking a separate piece of parchment on the bill, which is called a rider. The speaker then again opens the contents; and, holding it up in his hands, puts the question whether the bill shall pass. If this be agreed to, the title to it is then settled. After this, one of the members is directed to carry it to the lords, and desire their concurrence; who, attended by several more, carries it to the bar of the house of peers, and there delivers it to their speaker, who comes down from his woolsack to receive it. It there passes through the forms, as in the other house, (except engrossing, which is already done), and if rejected, no more notice is taken, but it passes *sub silentio*, to prevent unbecoming altercations. But if it be agreed to, the lords send a message by two masters in chancery (or, sometimes, in matters of high importance, by two of the judges) that they have agreed to the same; and the bill remains with the lords, if they have made no amendment to it. But if any amendments are made, such amendments are sent down with the bill to receive the concurrence of the commons. If the commons disagree to the amendments, a conference usually follows between members deputed from each house; who, for the most part, settle and adjust the difference: but if both houses remain inflexible, the bill is dropped. If the commons agree to the amendments, the bill is sent back to the lords by one of the members, with a message to acquaint them therewith. The same forms are observed *mutatis mutandis*, when the bill begins in the house of lords. But when an act of grace or pardon is passed, it is first signed by his majesty, and then read once only in each of the houses, without any new engrossing or amendment. And when both houses have done with any bill, it always is deposited in the house of peers, to wait the royal assent; except in the case of a money-bill, which after receiving the concurrence of the lords, is sent back to the house of commons. It may be necessary here to acquaint the reader, that both in the houses, and in their committees, the slightest expression, or most minute alteration, does not pass till the speaker, or the chairman, puts the question; which, in the house of commons, is answered by *aye* or *no*; and, in the house of peers, by *content*, or *not content*.

The giving the royal assent to bills is a matter of great form. When the king is to pass bills in person, he appears on his throne in the house of peers, in his royal robes, with the crown on his head, and attended by his great officers of state and heralds. A seat on the right hand of the throne, where the princes of Scotland, when peers of England, formerly sat, is reserved for the prince of Wales. The other princes of the blood sit on the left hand of the king; and the chancellor on a close bench removed a little backwards. The viscounts and temporal barons, or lords, face the throne, on benches, or wool-packs, covered with red cloth or baize. The bench of bishops runs along the house to the bar on the right hand of the throne; as the dukes and earls do on the left. The chancellor and judges, on ordinary days, sit upon wool-packs, between the barons and the throne. The common opinion is, that the house sitting on wool, is symbolical of wool being formerly the staple commodity of the kingdom. Many of the peers, on solemn occasions, appear in their parliamentary robes. None of the commons have any robes, excepting the speaker, who wears a long black silk gown; and when he appears before the king it is trimmed with gold. The royal assent may be given two ways; 1. In person. When the king sends for the house of commons to the house of peers, the speaker carries up the money bill or bills in his hand; and, in delivering them, he addresses his majesty in a solemn speech, in which he seldom fails to extol the generosity and loyalty of the commons, and to tell his majesty how necessary it is to be frugal of the public money. It is upon this occasion, that the commons of Great Britain appear in their highest lustre. The titles of all bills that have passed both houses are read; and the king's answer is declared by the clerk of the parliament in Norman-French. If the king consents to a public bill, the clerk usually declares, *le roy le veut*, "the king wills it so to be;" if to a private bill, *soit fait comme il est desiré*, "be it as it is desired." If the king refuses his assent, it is in the gentle language of *le roy s'avisera*, "the king will advise upon it." When a money-bill is passed, it is carried up and presented to the king by the speaker of the house of commons, and the royal assent is thus expressed, *le roy remercie ses loyal subjects, accepte leur benevolence, et auſſi le veut*, "the king thanks his loyal subjects, accepts their benevolence, and wills it so to be." In case of an act of grace, which originally proceeds from the crown, and has the royal assent in the first stage of it, the clerk of the parliament thus pronounces the gratitude of the subject; *le prelats, seigneurs, et commons, en ce present parliament assemblies, au nom de tout vous autres subjects, remercient tres humblement votre majesté: et prient a Dieu vous donner en santé bonne vie et longue*; "the prelates, lords, and commons, in this present parliament assembled, in the name of all your other subjects, most humbly thank your majesty, and pray to God to grant you in health and wealth long to live." 2. By the statute 33 Hen. VIII. c. 21. the king may give his assent by letters patent under his great seal signed with his hand, and notified, in his absence to both houses assembled together in the high house, by commissioners consisting of certain peers, named in the letters. And, when the bill has received the royal assent in either of these ways, it is then, and not before, a statute or act of parliament.

This statute or act is placed among the records of the kingdom; there needing no formal promulgation to give it the force of a law, as was necessary by the civil law with regard to the emperor's edicts; because every man in England is, in judgment of law, party to the making of an act of parliament, being present thereat by his representatives. However, copies thereof are usually printed at the king's press, for the information of the whole land. An act of parliament thus made, is the exercise of the highest authority that this kingdom acknowledges upon earth. It hath power to bind every subject in the land, and the dominions thereunto belonging; nay, even the king himself, if particularly named therein. And it cannot be altered, amended, dispensed with, suspended, or repealed, but in the same forms, and by the same authority of parliament; for it is a maxim in law, that it requires the same strength to dissolve as to create an obligation.

Such is the parliament of Great Britain: the source and guardian of our liberties and properties, the strong cement which binds the foundation and superstructure of our government, and the wisely concerted balance, maintaining an equal poise, that no one part of the three estates overpower or distress either of the other.

**PARLIAMENT HEEL**, the causing a ship to incline a little on one side, so as to clean the upper part of her bottom on the other, and cover it with fresh composition, which latter operation is called boot-topping.

**PARODY**, a poetical pleasantry, consisting in applying the verses written on one subject, by way of ridicule, to another; or in turning a serious work into a burlesque, by affecting to observe, as nearly as possible, the same rhymes, words, and cadences.

**PAROLE**, a term signifying any thing done verbally, or by word of mouth, in contradistinction to what is written; thus, an agreement may be by parole. Evidence also may be divided into parole evidence and written evidence. A parole release is good to discharge a debt by simple contract, 2 Show, 417. The holder of a bill of exchange may authorize another to indorse his name upon it.

**PARREL**, a machine used to fasten the sail-yards of a ship to the mast, in such manner as that they may be easily hoisted and lowered thereon; there are four different kinds of parrels, *viz. Parrel Rope*, is formed of a single rope well served, and furnished with an eye at each end; this being passed round the yard is seized fast on, the two ends are passed round the after part of the mast, and one of them being brought under and the other over the yard, the two eyes are lashed together with a piece of spun yarn; this is seldom used but for the top gallant or smaller yards. *Parrel with Ribs and Trucks*, is formed by passing the two parts of the parrel rope through the two holes in the ribs, observing that between every two ribs is strung a truck on each part of the rope. See the articles RIB and TRUCK. The ends of the parrel rope are made fast with seizings, these are chiefly used on the top-sail yards. *Parrel with Trucks*, is composed of a single rope passing through a number of trucks sufficient to embrace the mast; these are principally used for the cheeks of a gaff. *Truss* PARREL, is formed by fixing a rope upon the middle of the yard, which, passing at the back of the mast, is reeved through an iron thimble, spliced into another rope, (also fastened upon the yard,) and communicates with a tackle reaching to the deck, whereby it may be occasionally slackened or straitened; ships of war generally have two of these, one leading from each side, and they are peculiar to the lower yards.

**PARSLEY.** The uses of parsley, in cookery, both for sauce and garnish, are numerous and well known. It is, however, poisonous to several kinds of birds; and, although so commonly used at table, facts have been adduced, from which it would appear, that in some constitutions it occasions epilepsy, or at least aggravates the fits in those who are subject to that disease. Inflammation in the eyes has also been attributed to the use of it. Parsley is eaten with great avidity by sheep, and has been recommended for use, in several diseases of those animals, as well as in some diseases of horses. Both the roots and seed are employed in medicine. The former have a sweetish taste, accompanied with a slight warmth, and a flavour somewhat resembling that of the carrot; the latter are warm and aromatic. Parsley is an annual plant, a native of Sardinia, and propagated by seed, which is usually sown about the month of March.

**PARSNIPS**, are well-known edible roots, which are propagated by seed sown in February or March, and the roots are in perfection about October. These, besides their use as a vegetable for the table, are of great value for the feeding of cattle, horses, sheep, and hogs. Land in Guernsey, which lets for £7 an acre, is sown with parsnips to feed cattle: and the milk of the cows so fed is not only richer than it would otherwise be, but yields butter of fine saffron colour and excellent taste. If washed clean and sliced among bran, horses eagerly devour parsnips, and thrive well, though there is a notion that they are thereby subject to become blind. They fatten sheep and oxen in a short time; and for pigs they are at least equal if not superior to carrots. As food for mankind, they are considered extremely nutritive, and may with great advantage be kept on board ships for long voyages. It is, however, said that they should not be dug up for use in the spring, because, at that season, the nutritive juices rising upward to produce the seed, they are then unwholesome. Parsnips abound in saccharine juice; and various experiments have in vain been made with a view to extract sugar from them. In some parts of Ireland they are used instead of malt in brewing: and, when properly fermented, afford an agreeable beverage. The seeds are said in some cases to have proved an efficacious remedy in intermitted fevers.

**PARSON**, signifies the incumbent of a church. He is in himself a body corporate, in order to protect and defend the rights of the church by a perpetual succession. When a parson is instituted and inducted into a rectory, he is then, and not before, in full and complete possession. 1 Black. 391.

**PART**, in Music, the name of each of the melodies of any harmonic composition, and which, when performed in union, form its harmony. Four is the fewest number of parts with which the chords necessary to elaborate harmony, can be completely filled.

**PARTERRE**, in Gardening, a level division of ground, which, for the most part faces the south and best front of a house; and is generally furnished with evergreens, flowers, &c.

**PARTICLE**, the minute part of a body, or an assemblage of several atoms of which natural bodies are composed. This term is frequently used as synonymous with atom, corpuscule, and molacule, but sometimes it is distinguished from them.

**PARTIES**, in Law, signify the persons that are named in a deed or fine, *viz.* those that made the deed, or levied the fine, and also those to whom the same was made or levied.

**PARTING**, in Chemistry and Metallurgy, is an operation by which gold and silver are separated from each other. In this sense it is the same with refining metals, or obtaining them in a pure state. Gold and silver are called perfect metals, because they are capable of withstanding the action of very strong heat. All other metals are reduced to the state of oxides when subject to fire with access of air. Gold and silver may therefore be purified from baser metals, by keeping them melted till the alloy be destroyed. But this process is tedious and expensive, from the great consumption of fuel. A shorter and more advantageous method of refining gold and silver has been discovered. A certain quantity of lead is put into the crucible with the alloy of gold and silver, the whole is exposed to the action of the fire; and the lead being quickly converted by heat into an oxide, which is easily melted into a semi-vitrified and powerful vitrifying matter, called litharge, we have only to increase the proportion of imperfect metals, the litharge will prevent them from being so well covered and protected by the perfect metals; and by uniting with these imperfect metals, it communicates to them its property of being very easily oxidated. By its vitrifying and fusing property, exercised with force upon the calcined and naturally refractory parts of the other metals, it accelerates the fusion, scorification, and separation of these metals. In this operation the lead is scorified, and scorifies along with it the imperfect metals. It separates from the metallic mass, floats upon the surface of the melted mass, and becomes vitrified. But as the litharge would soon cover the melted metal, and by preventing the access of air, prevent the oxidation of the remaining imperfect metals, such vessels are employed as are capable of imbibing and absorbing in their pores the melted litharge, and thus removing it out of the way. Or, for large quantities, vessels are so constructed, that the fused litharge, besides being soaked in, may also drain off through a channel made in the corner of the vessel.

Vessels made of lixiviated wood or bone ashes, are most proper for this purpose. These vessels are called *cupels*, the process itself *cupellation*. The cupels are flat and shallow. The furnace should be vaulted, that the heat may be reverberated upon the surface of the metal during the operation. A crust, or dark-coloured pellicle, is continually forming upon the surface. When all the imperfect metal is destroyed, and the scorification has ceased, the surface of the perfect metal is seen clean and brilliant, forming a kind of fulguration, called lightning. By this mark, the metal is known to be refined.

*Purification of Gold by Antimony.*—When gold contains but a small quantity of alloy, it may be separated from the base metal by melting it in a crucible that will hold twice its quantity, throwing upon it, whilst in fusion, double its weight of crude antimony (sulphuret of antimony). The crucible is then covered, and the whole kept in a state of fusion for some minutes; and when the surface sparkles, it is poured into an inverted cone which has been previously heated and greased. By striking the cone on the ground, the metal will come out when cold. The mass consists of two substances; the upper part being the sulphur of the crude antimony, united with the impure alloy; and the lower part gold, united to some of the regulus of antimony. This gold may be separated from the regulus of antimony by exposure to less heat than will melt the gold, because antimony is volatile, and dissipates in such a heat. If the gold is not sufficiently purified by this first process, repeat it a second, and even a third time. When a part has been dissipated, more heat is required to keep the gold in fusion; the fire must therefore be increased towards the conclusion of the operation. The purification may be completed by throwing into the crucible a little crude antimony, which effectually calcines the remaining regulus of antimony. If, after these operations, the gold be deprived of its usual ductility, this may be restored by fusing it with nitre and borax. The sulphur of the antimony, though it unites with the basest metals, does not destroy them, but forms with them a scoria, from which they may be separated by treatment as an ore. Diagrams of crucibles are unnecessary; every one knows that a crucible is shaped like a wine glass. When the quantity of silver mixed with the gold is considerable, they may be separated by other processes. Nitric acid, muriatic acid, and sulphur, which cannot dissolve gold, attack silver very easily; these three agents furnish methods of separating silver from gold, and the operation is called *parting*. Parting by nitric acid being the most convenient, is almost the only one employed by goldsmiths and coiners, who call it simply parting. That performed by muriatic acid is only made by cementation, and receives the name of concentrated parting. Lastly, parting by sulphur is effected by fusion; it is called dry parting.

*Parting Gold from Silver by Nitric Acid.*—Though parting by nitric acid be easy, it cannot succeed exactly, unless we attend to some essential circumstances. The gold and silver must be in a proper proportion; for if the gold be in too great a quantity, it would cover the silver, and guard it from the action of the acid; therefore when assayers know not the proportions of gold to silver in the mass, they rub the mass on a touch-stone of black basaltes, so as to leave a mark upon it; they then make similar marks with their proof-needles, (needles composed of gold and silver alloyed in graduated proportions,) and by comparing the colour of the several marks, they discover the probable scale of admixture. If the trial shews that in a given mass the silver is not to the gold as three to one, it will not serve for the operation of parting by aqua-fortis, and the quantity of silver necessary to make an alloy of that proportion must be added. This operation is called quartation, because the gold is reduced to a fourth of the whole mass. No inconvenience arises from the quantity of silver being too great, except a waste of aqua-fortis. The nitric acid, or aqua-fortis, employed, must be pure, and free from sulphuric and muriatic acids. Its purity must therefore be ascertained; and if this be found not sufficient, the acid must be purified by nitrate of silver. If the purity of the nitric acid were not attended to, a great quantity of silver proportionable to these two foreign acids, would be separated during the solution: and this portion of silver converted by these acids to sulphate of silver, and to muriate of silver, would remain mingled with the gold. When the metallic mass is properly alloyed, it is to be reduced to plates called cornets, or to grains, rolled up spirally. These are put into a matrass, and upon them there is poured a quantity of aqua-fortis, whose weight is to that of silver as three to two; and as the nitric acid employed for this operation is weak, the solution is at first assisted by the heat of a sand bath, on which the matrass is placed. When no further mark of solution appears, the aqua-fortis charged with silver is decanted. Fresh nitric acid, stronger than the former, but in less quantity, is poured into the matrass. This is boiled in the remaining mass, and decanted as the former. Aqua-fortis must be boiled a third time on the remaining gold, that all the silver be dissolved. The gold then washed with boiling water, is very pure, if the operation has been performed with due attention. It is called, gold of parting.

The silver disolved in aqua-fortis may be separated by distillation. In this case all the aqua-fortis is recovered pure, and fit for another parting. Or it may be precipitated by some substance having a greater affinity than this metal with nitric acid. In the ascent, copper is generally employed for this purpose. The solution of silver is put into copper vessels. The aqua-fortis dissolves the copper, and the silver precipitates; the new solution being decanted, is then a solution of copper. The precipitate is well washed, and melted into an ingot, called parted silver. When this silver has been obtained from a mass which had been refined by lead, and when it has been well washed from the solution of copper, it is very pure. Or the silver may be separated from the nitric acid by adding to it muriatic acid, with which it forms muriate of silver. Muriate of silver may be decomposed by mixing it with soda, and exposing it to a sufficient heat in a crucible; by this means the soda unites to the muriatic acid, and sets the silver free.

*Verditer.*—The refiners frequently employ this solution of copper obtained in the process of parting, for making verditer; which is prepared by adding quick lime to the solution: a precipitate takes place, which is the blue pigment known by the name of verditer.

*Parting Gold from Silver by Cementation.*—This is also called concentration, when the quantity of gold is so great to that of the silver, as to render it a difficult task by aqua-fortis. The mixed metal to be cemented is reduced to plates as thin as small pieces of money. At the bottom of the crucible, or melting pot, is laid a stratum of cement, composed of four parts of brick dust, one part of green copperas (sulphate of iron) calcined to redness, and one part of common salt, about the thickness of a finger in depth. Upon this stratum a layer of plates of the metal is placed, and then another stratum of cement, and so on till the crucible is filled. It is now placed in a furnace, or oven (after a top has been luted on the crucible), and exposed for twenty-four hours, till it becomes red-hot, but not melted. The fire is now left to go out, and the metal to cool, that it may be separated from the cement, and boiled repeatedly in pure water. This gold is afterwards tried on a touch-stone; and if not sufficiently purified, the process is performed a second time. By the above method, we see how powerfully silver is dissolved by marine acid, when in a state of subtile vapour, that has been disengaged from the common salt of the cement. Nitre may be used instead of common salt, as the nitrous acid readily dissolves silver; but the mixing of common salt and nitre together is highly injudicious, because the joint acids are liable to dissolve some of the gold with the silver. Whatever silver has been separated, will now remain in the cement: but it may be freed from this by lead, in the method described in cupellation.

*Parting Gold from Silver in the Dry Way.*—This, called also parting by fusion, is performed by means of sulphur, which has the property of uniting easily with silver, while it does not attack gold. This dry parting, is troublesome and expensive, and is not undertaken but when the silver far exceeds the gold, because sulphur will not separate it so easily as aqua-fortis, and will therefore require a further application to cupellation and solution.

*Refining Silver by Nitre.*—The principle of this operation is founded on the property of nitre to oxydate very powerfully all base metals; whereas the precious metals are not affected by it. For as the metallic oxides and glasses remain not united with reguline metals, and as these latter, when in fusion, sink to the bottom on account of their great specific gravity, they may be easily parted from the scoria. The silver to be purified by nitre is first granulated, then mixed with a fourth part of its weight of dry nitre, an eighth part of potash, and a little common glass, all in powder. This mixture is put into a crucible, two-thirds full. The crucible is covered with a smaller crucible inverted, in the bottom of which a small hole has been made. Both are luted, and placed in a furnace capable of drawing air to make the fire intense enough to melt the silver. Then into the furnace charcoal is put to such a height, that only the top of the inverted crucible shall be uncovered. The coal is then kindled, and the vessels made moderately red, and a hot coal put upon the small hole in the bottom of the inverted crucible. If a shining light be observed round this coal, and a slight hissing noise at the same time heard, the operation proceeds well. The fire is now sustained at the same degree till these appearances cease, when it is increased, so that the silver be well melted, and then the crucibles are taken out of the furnace. The large crucible is broken when it is cold, and the silver will be found at the bottom covered with green alkaline scoria. Some silver is apt to be lost in this operation, by the swelling and detonating of the nitre, which often forces it through the hole in the upper crucible, unless great care be used; this method has, however, its advantages, being more expeditious than cupellation.

*Separating Silver from Copper by Eliquation.*—When in a large way, it is desired to separate a small quantity of silver from much copper with which it is alloyed, the process called eliquation is resorted to. The operation depends on the nearer affinity of silver with lead than with copper: hence it fuses, and combines with lead at a degree of heat in which copper does not fuse.

*Whitening Silver by Boiling.*—The whitening of silver by boiling is one of the methods of parting copper from silver in the humid way. The silver wrought in any shape is first ignited to redness, then boiled in a ley of muriate of soda and acidulous tartrate of potash, and by so doing the copper is removed from the surface, and the silver receives a whiter appearance.

*Precipitating Silver by Copper.*—Copper has a much greater affinity with oxygen than silver; hence the silver is precipitated from its solutions as a fine silver dust, by metallic copper. This likewise affords a means of discovering what portion of silver may be contained in an alloy of silver and copper. A quantity of the mixture determined by weight is dissolved in nitric acid; the solution is diluted with filtered water, and a plate of copper hung in it, till no more precipitate. The weight of the precipitate, when edulcorated, is then compared with that of the whole alloyed metal put to trial. This silver dust, well washed, and mixed with gum water, is used in water painting.

*Separating Silver from Copper by an Alkaline Sulphuret.* The affinity of copper with sulphur is stronger than that of silver; hence liver of sulphur (sulphuret of potash) has been proposed as an expedient to free silver from copper; for if silver containing copper be fused with alkaline sulphuret, the base metal will combine with the latter, and be converted into scoria floating on the silver.

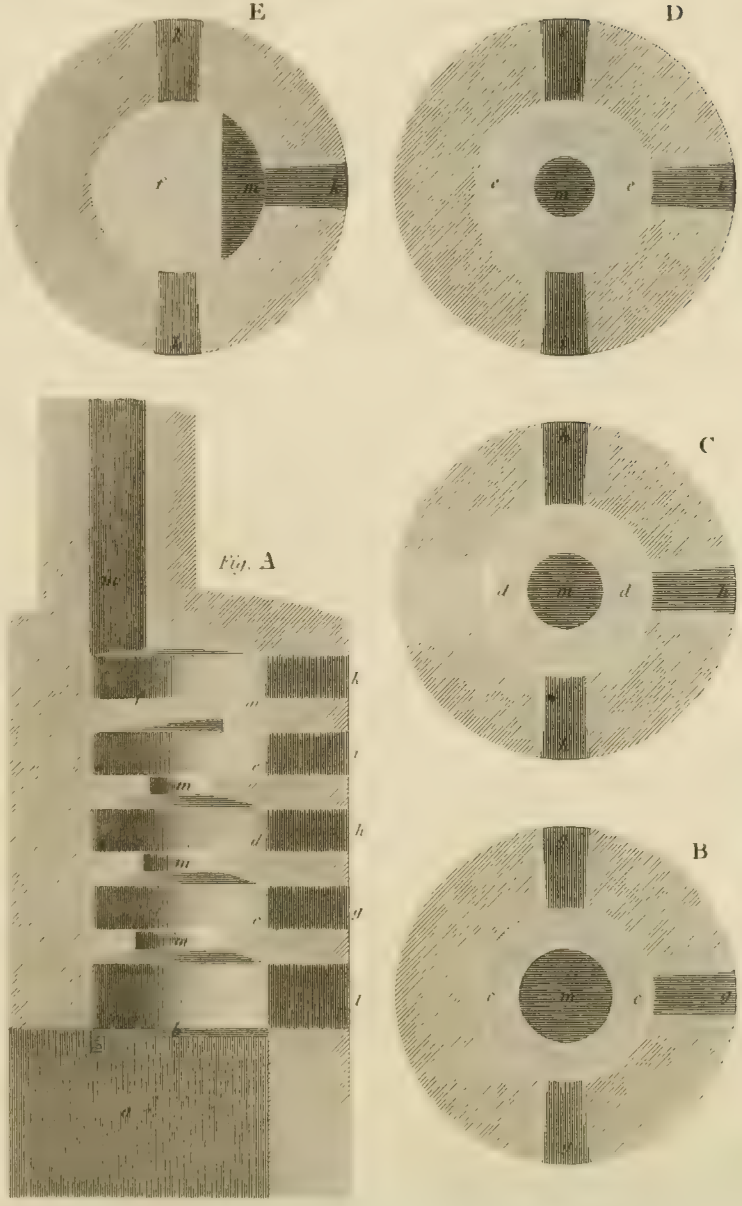
*Keir's Mode of Separating Silver from Copper.*—A compound acid that will act exclusively upon silver, is made by dissolving one pound of nitrate of potash (common nitre or saltpetre), in eight or ten pounds of sulphuric acid (oil of vitriol), or by mixing sulphuric and nitric acids. This acid dissolves silver easily, while it will not attack copper, iron, lead, gold, or platina.

These properties have rendered it capable of a very useful application in the arts. Among the manufactures at Birmingham, that of making vessels of silver, plated on copper, is a very considerable one: and the method of effecting the separation of silver and copper, by means of the above mentioned compound of sulphuric acid and nitre is now commonly practised by the manufacturers at Birmingham, and is much more economical, and much easier executed, than any method previously practised; nothing more is necessary than to put the pieces of plated metal into a glazed earthen pan, pour upon them some of the acid liquor, stir them about, that the surfaces may be frequently exposed to fresh liquor, and assist the action by a gentle heat, from 100° to 200° of Fahrenheit's thermometer. When the liquor is nearly saturated, the silver is precipitated from it by common salt, forming muriate of silver, or luna cornea, easily reducible to a metallic state, by melting it in a crucible with a sufficient quantity of potash; and lastly, by refining the melted silver, if necessary, with a little nitre thrown upon it. In this manner the silver will be obtained sufficiently pure, and the copper will remain unchanged. Else the silver may be precipitated in its metallic state, by adding to the solution of silver a few of the pieces of copper, and a sufficient quantity of water to enable the liquor to act upon the copper.

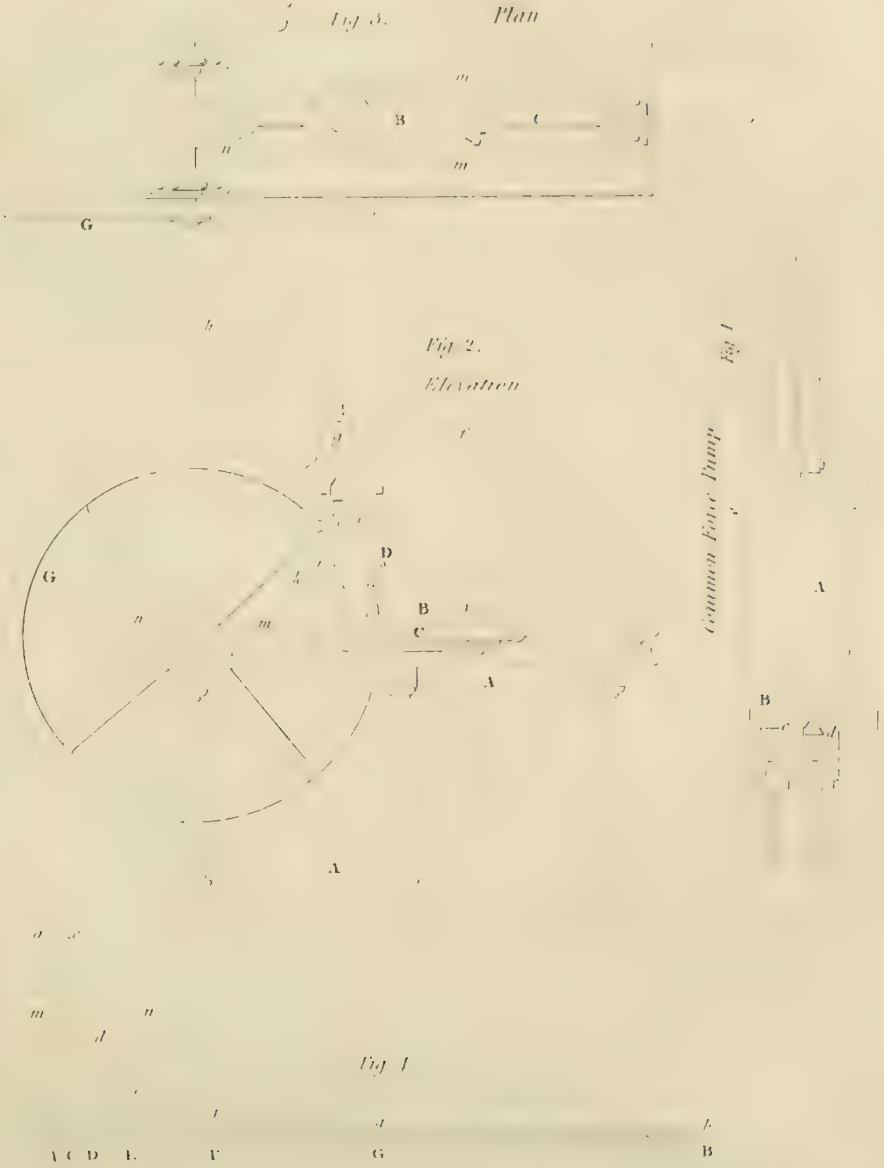
*A Method of obtaining Gold in a Pure State.*—Perfectly pure gold is obtained by dissolving the gold of commerce in nitro-muriatic acid, and precipitating the metal, by adding a weak solution of sulphate of iron. The precipitate, after being well washed and dried, is pure gold.

*A Method of obtaining Silver in a Pure State.*—Dissolve the silver of commerce in nitric acid, and add to it some muriatic acid; a white curdy precipitate, called muriate of silver, will

## Lord Bute's Furnace, constructed by Mr. Peter Woulfe.



## The new Hydro-Pneumatic Pump



be formed. To reduce this to the metallic state, mix one part of it with three of soda, expose the whole to a white heat, and when the mixture is well fused, suffer it to cool; then break the crucible, and separate the pure silver from the muriate of soda which has been formed.

**PARTING**, the state of being driven from the anchors, by breaking the cables through the violence of the wind, waves, &c.

**PARTITION**, is a dividing of lands descended by the common law, or custom, among coheirs or parceners, where there are two at the least.

**PARTNER.** If there are several joint partners, and a person has dealings generally with one of them in matters concerning their joint trade, whereby a debt becomes due to the said person, it shall charge them jointly, and the survivors of them; but if the person only dealt with one of the partners upon a separate account, in that case the debt shall only affect that partner and his executors. If one or more of the joint traders become bankrupt, his or their proportions are only assignable by the commissioners, to be held in common with the rest who are not bankrupts. If one of two partners become a bankrupt, the commissioners cannot meddle with the interest of the other, for it is not affected with the bankruptcy of his companion. Payment to one of the partners, is payment to them all.

**PARTNERS**, in Naval matters, pieces of planks nailed round the several scuttles or holes in a ship's decks, wherein are contained the masts and capstans; they are used to strengthen the deck where it is weakened by those breaches, but particularly to support it when the mast leans against it. *Partners*, is also a name given to the scuttles themselves.

**PARTNERSHIP**, a contract among two or more persons to carry on a certain business, at their joint expenses, and share the gain or loss which arises from it. All debts contracted under the firm of a company are binding on the whole of the partners, though the money was borrowed by one of them for his own private use, without the consent of the rest. When a partner in a company becomes insolvent, the company is not bound for his debts beyond the extent of his share. Partnership is dissolved by the death of a partner; yet where there are more than two, it may be renewed by agreement.

**PART-OWNERS**, are partners interested, and possessed of certain shares in a ship. Owners are tenants in common with each other; but one or more joint-owners refusing to contribute their quota to the outfit of the vessel, cannot prevent her from going to sea against the consent of the majority of the owners, who, giving security in the Admiralty, may freight the ship at their own exclusive risk, by which the smaller dissentient number of owners will be excluded at once from any share, either in the risk or in the profits.

**PARUS**, or Titmouse, in Ornithology, a genus belonging to the order passeres, of which there are fourteen species.

**PASCAL**, Blaise, a very excellent French mathematician and philosopher, was born at Clermont, in Auvergne, in 1623. He discovered very early an extraordinary genius for mathematical and philosophical inquiries, and is said to have formed a system of geometry, at the age of twelve years, without having seen any work on the subject, these having been carefully kept from him by his father, lest they should divert him from his literary pursuits.

**PASQUIN**, a mutilated statue at Rome, in a corner of the palace of the Ursini; it takes its name from a cobbler of that city, called Pasquin, famous for his sneers and gibes, and who diverted himself with passing his jokes on all the people who went through that street.

**PASS**, or Passport, a permission granted by any state to navigate in some particular sea without hinderance or molestation; it contains the name of the vessel and that of her master, together with her tonnage, and the number of her crew, certifying that she belongs to the subjects of a particular state, and requiring all persons at peace with that state to suffer her to proceed in her voyage without interruption.

**PASS**, a strait, difficult, and narrow passage, which shuts up the entrance into a country. The first care of the general of an army is, to seize the passes of the country into which he would carry the war, to fortify them, and take care that they are well guarded.

Pass, or *Passade*, in Fencing, an advance or leap forward upon an enemy. Of these there are several kinds; as, passes within, above, beneath, to the right, the left, and passes under the line, &c.

Pass *Parole*, a command given, which passes from mouth to mouth along the line of a regiment or army.

**PASSAGE**, or Passo, any phrase, or short portion of any air, or other composition. Every member of a strain or movement is a passage.

**PASSAGE** Boat, a small vessel, employed in carrying persons or luggage from one port to another.

Passage, *Birds of*. *See* Migration and Ornithology.

**PASSAGIO**, (Italian,) a succession of sounds so connected in their melody and expression, as to form a member or phrase in the composition.

**PASSANT**, in Heraldry, a term applied to a lion or other animal, in a shield, appearing to walk leisurely.

**PASSAREE**, a rope to confine the tacks towards the ship when she is going large in light breezes; it is, however, very rarely used.

**PASSERES**, in Natural History, the sixth order of birds according to the Linnæan system. They live chiefly in trees and hedges, are monogamous, vocal, and feed the young by thrusting the food down their throats.

**PASSIFLORA**, or Passion Flower, a genus of plants belonging to the gynandria class, and in the natural method ranking under the 34th order, cucurbitaceæ.

**PASSPORT**, or Pass, a license or writing obtained from a prince or governor, granting liberty and safe-conduct to pass through his territories without molestation. Passport also signifies a license obtained for importing contraband goods, or for exporting and importing merchandise without paying the duties; these last licenses are always given to ambassadors and other public ministers for their baggage, equipage, &c.

**PASTE.** Imitations of gems are so called. Such substances are selected, to be fused together, as will produce an artificial glass, resembling in appearance the gem intended, and sufficiently hard and beautiful. The art has been brought to such perfection, that it requires a very close inspection of the skilful to be able to distinguish the real from the apparent. The art is much encouraged, not only by the vain, who are unable even to procure real gems, but also to replace for a time the diamonds of such persons as find it convenient to procure a temporary loan by pledging their jewels. Silex, borax, red oxide of lead, potass, and sometimes arsenic, are the base of all artificial stones. The fusion should be kept up moderately twenty-four hours together. We shall close this article with the following

*Description of a Furnace constructed for Lord Bute by Mr. Peter Woulfe, for Experiments on Pastes, or Coloured Glasses.*—The furnace, of which we have given a vertical, and horizontal section, (in plate *Lord Bute's Furnace, &c.*) is a copy of a drawing in a manuscript book of experiments and memorandums, in the hand-writing of Mr. Woulfe, (the contriver of the apparatus that goes by his name,) who gives the following description of it:—In this furnace, which is drawn on a scale of one-sixteenth of an inch to the inch, two hundred experiments on the formation of coloured pastes or glasses may be made at once. In the drawing, where the same letters occur in different sections, they refer to the same parts of the furnace. Fig A, is a vertical section of the furnace; *a*, the ash pit, or air hole, which opens on the outside of the house, and has an iron door with a register in it; *b*, the grate and fireplace; *c c*, the first chamber, for one circular row of large crucibles, placed on the floor *c c*; *d d*, the second chamber or floor, for two rows of crucibles; *e e*, the third chamber, for two rows of crucibles; *f*, the fourth chamber, for tests or crucibles; *g*, *h*, *i*, *k*, doors opening into the four chambers, each of which has three doors: see the same letters in the horizontal sections BCDE. *l*, the door of the furnace. *m m m m m*, the flue in the building, which rises three stories high. B is a horizontal section of the first chamber; *c c*, the floor or circular shelf on which the crucibles are placed; *g g g*, three doors or openings. C, a horizontal section of the second chamber; *d d*, the floor or shelf; *h h h*, the doors. Fig. D, a section of the third chamber; shewing its shelf or floor *e e*, and its three doors *i i i*. Fig. E, section of the fourth or upper chamber, in which *f* is the floor, and *k k k* the three doors for putting in, or taking out, tests or crucibles. A shilling put into a red-hot test in this chamber, melted in one minute and a half. The front of the furnace is at the side answering to the middlemost of the three doors on the respective floors, *viz.* the side marked *l g h i k*, in fig. A. The best way of understanding the use of such things, is by visiting the workshops of artists employed in the manufacture of artificial gems.

**PASTEBOARD**, a kind of thick paper, formed of several sheets of paper pasted together. The chief use of pasteboard is in binding books, making letter-cases, &c. *See* Paper.

**PASTORAL**, in general, something that relates to shepherds; hence we say, pastoral life, manners, poetry, &c. The origin of poetry is ascribed to that age which succeeded the creation of the world; and as the keeping of flocks seem to have been the first employment of mankind, the most ancient sort of poetry was probably pastoral.

**PASTURE**, is generally any place where cattle may feed, and in law, is mostly applied to a common of pasture, or right of feeding cattle on certain waste lands.

**PATEE**, or **Pattee**, in Heraldry, a cross, small in the centre, and widening to the extremes, which are very broad.

**PATELLA**, or **Limpet**, a genus of insects belonging to the order vermes testacea. They are always attached to some hard body. Their summit is sometimes acute, sometimes obtuse, flatted, turned back, or perforated.

**PATENT**, in general, denotes something that stands open or expanded; thus, a leaf is said to be patent when it stands almost at right angles with the stalk.

**Patent**, or *Letters Patent*, are writings sealed with the great seal of England, by which a man is authorized to do, or to enjoy, any thing which of himself he could not. They are so called on account of their form, being open, with their seal affixed, ready to be exhibited for the confirmation of the authority delegated by them. Letters patent, for new inventions, are obtained by petition to the crown: they go through many offices, and are liable to opposition, on account of the want of novelty, &c. and if obtained, and it can be proved that the invention was not new, or had been made public previously to the granting the patent, they may be set aside. A patent at the lowest cost, and when no opposition is given to it, will, for fees of office, specification, &c. cost for the three branches of the United Kingdom, three hundred pounds.

**PATHOLOGY**, that part of medicine which explains the symptoms of diseases.

**PATROL**, in war, a round or march made by the guards, or watch, in the night-time, to observe what passes in the streets, and to secure the peace and tranquillity of a city or camp. The patrol generally consists of a body of five or six men, detached from a body on guard, and commanded by a sergeant.

**PATRON**, in the canon and common law, is a person, who having the advowson of a parsonage, vicarage, or the like spiritual promotion, belonging to his manor, has, on that account, the gift and disposition of the benefice, and may present to it whenever it becomes vacant.

**PATRONYMIC**, among Grammarians, is applied to such names of men and women as are derived from those of parents or ancestors.

**PAUL**, a short bar of wood or iron, fixed close to the capstan or windlass of a ship, to prevent those engines from rolling back or giving way, when they are charged with any great effort. *Paul Bits*, are pieces of timber fixed perpendicularly before the windlass, near the middle of it, and serving as supports to the pauls which are pinned into them.

**PAULICIANS**, Christians of the seventh century, disciples of one Constantine, a native of Armenia, and a favourer of the errors of Manes.

**PAUPER**. A person receiving public charity.

**PAUSE**, in Music, a mark or character, consisting of a curve drawn over a dot, and signifying that the note or the rest, over which it is placed, is to be continued beyond the regular time.

**PAVEMENT**, a layer of stone or other matter, serving to cover and strengthen the ground of divers places for the more commodious walking on. In London the pavement for coach ways is chiefly a kind of granite from Scotland; and on the footpath Yorkshire paving is used; the kirbstone is usually of Scotch granite; courts, stables, kitchens, halls, churches, &c are paved usually with tiles, bricks, flags, or fire stones; and sometimes with a kind of freestone and rag stone. In France, the public roads, streets, courts, &c. are paved with gres, a kind of freestone. In Venice, the streets, &c. are paved with brick; churches sometimes with marble, and sometimes with Mosiac work. In Amsterdam, and the chief cities of Holland, they call their brick pavement, the burgomasters' pavement, to distinguish it from the stone or flint pavement, which is usually in the middle of the street, serving for the passage of their horses, carts, coaches, and other carriages; the brick borders being designed for the passage of people on foot.

**PAVO**, the *Peacock*, in Ornithology, a genus belonging to the order of gallinæ. The head is covered with feathers which bend backwards; the feathers of the tail are very long, and beautifully variegated with eyes of different colours. Latham enumerates eight species. These birds feed almost solely on insects and grain. They prefer elevated situations for roosting, choosing the tops of houses and the highest trees for this purpose. They were considered as luxuries for the table by the Romans, and the young ones are now regarded as a delicacy. Their voice is harsh and dissonant, and in perfect contrast to that beauty exhibited by their plumage, which, in the language of Buffon, "seems to combine all that delights the eye in the soft and delicate tints of the finest flowers, all that dazzles in the sparkling lustre of the gem, and all that astonishes in the grand display of the rainbow."

**PAVO ET INDUS**, *the Peacock and Indian*, a constellation situated on the Antarctic circle, contains twenty-six stars, of which one is of the 2nd magnitude, three of the 3d, and four of the 4th. The brilliant $\alpha$ is made of the eye of the proud bird. It has 20 ho. 11′ 30″ right ascension in Time, (*Ann. Var.* 4″.84,) and 57° 17′ 41″. S. declination, (*Ann. Var.* 10″.72.)

**PAWN**, a pledge lodged for the security of the payment of a sum of money borrowed.

**PAY, To**, as a naval term, implies to daub or anoint the surface of any body, in order to preserve it from the injuries of the water, weather, &c. *To Pay a Vessel's Bottom*, to cover it with a composition of tallow, sulphur, rosin, &c.

**PAYING Off**, the movement by which a ship's head falls to leeward, particularly when, by neglect of the helmsman, she had inclined to windward of her course, so as to make the head sails shiver in the wind. *Paying off*, also implies the payment of the ship's officers and crew, and the discharge of the ship from actual service. *Paying out*, or *Paying away*, the act of slackening a cable or other rope, so as to let it run out of the vessel.

**PAYMENT**, is the consideration or purchase-money for goods, and may be made by the buyer giving to the seller the price agreed upon, either by bill or note, or by money.

**PEACE**, in Law, signifies a quiet and harmless behaviour towards the king and his people.

**PEACE, Justices of.** *See* Justice of the Peace.

**PEACH.** This rich and delicious fruit is highly and deservedly esteemed at table, as an article in our deserts; and when ripe and fresh, is grateful and wholesome, seldom disagreeing with the stomach, unless this organ be not in a healthy state, or the fruit has been eaten to excess. When preserved in wine, brandy, or sugar, it loses its good properties. The kernels yield a salubrious bitter. The flowers, which are very beautiful, and appear only in the spring, emit an agreeable odour, have a bitterish taste, and, including the calyx as well as the corolla, are used for medical purposes. The leaves are occasionally employed in cookery, but they ought not to be used without great caution, on account of their injurious properties. There are many varieties of the peach, some of which are much more esteemed than others. The mode in which the trees are usually propagated is by a process usually termed budding, or grafting upon the stock of some other tree; and by this process those of any favourite kind may be exactly obtained.

**PEAK**, a name given to the upper corner of those sails which are extended by a gaff, or by a yard which crosses the mast obliquely, as the mizzen yard of a ship, the main yard of a bylander, &c. The upper extremity of these yards and gaffs are also denominated the peak.

**Peak** *Haliards*, are the ropes or tackles by which the outer end of a gaff is hoisted, as opposed to the throat halliards.

**PEAR, The Common**, is a well-known garden fruit, derived from an English stock, (the wild pear tree,) which grows in hedges and thickets in Somersetshire and Sussex. It would be an endless task to describe the different known varieties of the cultivated pear. Some of these are very large, and others extremely small; some have a rich and luscious flavour, and others, as the iron pear, are so hard and disagreeable to the taste, as to be absolutely unfit to eat. Pears are chiefly used in desserts; and one or two of the kinds are stewed with sugar, baked, or preserved in syrup. The fermented juice of pears is called perry, and is prepared nearly in the same manner as that of apples is for cider. The greatest quantities of perry are made in Worcestershire and Herefordshire. The Squash, the Oldfield, and the Barland perry, are esteemed the best. Many of the dealers in Champaigne wine are said to use perry to a great extent in the adulteration of it; and, indeed, really good perry is little inferior in flavour or quality to Champaigne. Of the wood of the pear tree, which is light, smooth, compact, and of a yellowish colour, carpenters' and joiners' tools are usually made, as well as the common kinds of flat rulers, and measuring scales. It is also used for picture frames that are to be stained black. The leaves impart a yellow die, and are sometimes employed to communicate a green colour to blue cloth.

**PEARLS**, are a calculus or morbid concretion, formed in consequence of some external injury which the muscle or shell-fish receives that produces it, particularly from the operations of certain minute worms which occasionally bore even quite through to the animal. The pearls are formed in the inside on these places. Hence it is easy to ascertain, by the inspection of the outside only, whether a shell is likely to contain pearls. If it be quite smooth, without cavity, perforation, or callosity, it may with certainty be pronounced to contain none. If, on the contrary the shell be pierced or indented by worms, there will always be found either pearls, or the embryos of pearls. It is possible, by artificial perforation of the shells, to cause the formation of these substances. The process which has been chiefly recommended, is to drill a small hole through the shell, and to fill it up with a piece of brass wire, riveting this on the outside like the head of a nail; and the part of the wire which pierces the interior shining coat of the shell, will, it is said, become covered with a pearl. As to the value of British pearls, some have been found of size so large as to be sold for £20 each, and upwards; and £80 was once offered and refused for one of them. It is reported in Wales, that a pearl from the river Conway, which was presented to the queen of Charles the Second, was afterwards placed in the regal crown.

*The Oriental* Pearl *Muscle* to which we are indebted for nearly all the pearls of commerce, has a flattened and somewhat circular shell, about eight inches in diameter; the part near the hinge bent or transverse, and imbricated (or covered like slates on a house) with several coats, which are toothed at the edges. Some of the shells are externally of sea-green colour, others are chesnut or reddish, with white stripes or marks; and others whitish with green marks. These shells are found both in the American and Indian seas. The principal pearl fisheries are of the casts of Hindoostan and Ceylon. They usually commence about the month of March, and occupy many boats and a great number of hands. Each boat has generally twenty-one men, of whom one is the captain, who acts as pilot; ten row and assist the divers, and the remainder are divers, who go down into the sea alternately by five at a time. The king of Persia has a pear-shaped pearl so large and pure as to have been valued at £110,000 sterling. The largest round pearl that has been known, belongs to the Great Mogul, and is about two-thirds of an inch in diameter. Pearls from the fishery of Ceylon are considered more valuable in England than those from any other part of the world. The smaller kinds are called *seed* or *dust pearls*, and are of comparatively small value, being sold by the ounce, to be converted into powder.

*To make Artificial* Pearls, take the blay or bleak fish, common in the Thames, scrape off the silvery scales from the belly; wash and rub these in water. Then suffer this water to settle, and a sediment will be found, of an oily consistence. A little of this is to be dropped into a hollow glass bead of a bluish tint, and shaken about so as to cover all the internal surface; after this, the bead is filled up with melted white wax, to give it solidity and weight.

*To Whiten discoloured* Pearls.—Soak them in hot water, in which some bran with a little tartar and alum have been boiled, rub them gently between the hands, which may be continued until the water grows cold, or until the object is effected, when they may be rinsed in lukewarm water, and laid on writing paper in a dark place to cool.

**PEAT**, is one of the most important productions of alluvial ground; it may be regarded as belonging more properly to the vegetable than to the mineral kingdom. Peat formerly covered extensive tracts in England, but is disappearing before the genius of agricultural improvement, which has no where produced more important effects than in the conversion of the black and barren peat moors of the northern counties into valuable land, covered with luxuriant herbage, and depastured by numerous flocks. It consists of wet spongy black earth, and decayed vegetables.

**PEBBLES**, the name of a genus of fossils, distinguished from the flints by having a variety of colours. These are defined to be stones composed of crystalline matter debased by earths of various kinds in the same species, and then subject to veins, clouds, and other variegations, usually formed by incrustation round a central nucleus, but sometimes the effect of a simple concretion; and veined like the agates, by the disposition which the motion of the fluid they were formed in gave their different coloured substances.

**PECK**, an English measure, the fourth part of a bushel.

**PECTEN**, the *Scallop*, a genus of shell fish, the characters of which are these: the animal is a tethys; the shell bivalve and unequal; the hinge toothless, having a small ovated hollow.

**PECORA**, in Natural History, the fifth order of the class Mammalia. There are eight genera, *viz.* Antelope, Bos, Camelus, Camelopardalis, Capra, Cervus, Moschus, Ovis.

**PECULIAR**, signifies a particular parish or church that hath jurisdiction within itself for probate of wills, &c. exempt from the ordinary, and the bishop's court. The Court of Peculiars is that which deals in certain parishes, lying in several dioceses; which parishes are exempt from the jurisdiction of the bishops of those dioceses, and are peculiarly belonging to the archbishop of Canterbury, within whose province there are fifty-seven such peculiars.

**PEDESTAL**, in Architecture, the lowest part of an order of columns, being that part which sustains the column, and serves as a foot on which it may stand erect.

**PEDICELLAIA**, a genus of insects belonging to the order vermes mollusca.

**PEDICULUS**, *Louse*, a genus of insects of the order aptera.

**PEEK**, is a term used in various senses. An anchor is said to be a-peek when the ship being about to weigh, comes over her anchor, so that the cable hangs perpendicularly between the hawse and the anchor. (See the articles Anchor and A-peek.) Also, the bringing a ship into the above position is called heaving a-peek. She is likewise said to ride a-peek when lying with her main and fore yards hoisted up, one end of her yards is brought down to the shrouds, and the other raised up on end; which is chiefly done when she lies at rest in rivers, lest other ships, falling foul of her, should break her yards. *Peek* is also used for the room in the hold, from the bitts forward to the stern. In this place men of war keep their powder, and merchantmen their victuals.

**PEER**, in general, signifies an equal, or one of the same rank and station; hence, in the acts of some councils, we find these words, "with the consent of our peers, bishops, abbots," &c. Afterwards the same term was applied to the vassals or tenants of the same lord, who were called peers, because they were all equal in condition, and obliged to serve and attend him in his courts; and peers in fiefs, because they all held fiefs of the same lord. The term peers is now applied to those who are impanelled in an inquest upon a person for convicting or acquitting him of any offence laid to his charge; and the reason why the jury is so called, is, because by the common law, and the custom of this kingdom, every person is to be tried by his peers, or equals; a lord by the lords, and a commoner by commoners.

Peer *of the Realm*, a noble lord who has a seat and vote in the house of lords, which is also called the house of peers.

These lords are called peers, because, though there is a distinction of degrees in our nobility, yet in public actions they are equal, as in their votes in parliament, and in trying any nobleman, or other person, impeached by the commons, &c. A peer is not to be put upon any inquest, even though the cause has a relation to two peers; but in trials where any peer is either plaintiff or defendant, there must be two or more knights returned on the jury. Where a peer is defendant in a court of equity, he is not to be sworn to his answer, but it may be upon his honour, as in the trial of peers; however, when a peer is to answer to interrogatories, or to make an affidavit, or is to be examined as a witness. he is to be sworn.

**PEERESS**, a woman who is noble by descent, creation, or marriage. If a peeress by descent or creation marries a person under the degree of nobility she still continues noble; but if she obtains that dignity only by marriage, she loses it on her afterwards marrying a commoner; yet by the courtesy of England she alway retains the title of her nobility. No peeress can be arrested for debt or trespass; for though, on account of their sex, peeresses cannot sit in the house of lords, yet they enjoy the privileges of peers, and therefore all peeresses by birth are to be tried by their peers.

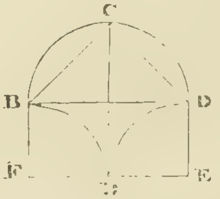
**PEGASUS**, one of the old constellations, and known as the fabled favourite of the Muses, is a paratanellon of Aquarius, and the zodiacal Fishes. We think this affinity is far more symbolical of the inroad of the Scythians into Egypt in the 7th century, than of the ark of Noah, before the Christian era; though it is not to be denied that the arkite and solar worship are frequently confounded in a much more extraordinary way, than the debased and slavish Romans confounded science and folly, by the deification of Antonius, whose medals, statutes, temples, city, oracles, and constellations, are well known, and still dishonour the memory of Hadrian.

**Pegasus**, is also a genus of fishes, of the order nantes.

**PELAGIANS**, a Christian sect who appeared before the latter part of the fourth, or the beginning of the fifth century. They are said to have maintained, 1. That Adam was by nature mortal, and whether he had sinned or not would certainly have died. 2. That the consequences of Adam's sin were confined to his own person. 3. That new-born infants are in the same condition with Adam before the fall. 4. That the law qualified men for the kingdom of heaven, and was founded upon equal promises with the gospel. 5. That the general resurrection of the dead does not follow in virtue of our Saviour's resurrection. 6. That the grace of God is given according to our merits. 7. That this grace is not granted for the performance of every moral act; the liberty of the will, and information in points of duty, being sufficient, &c.

**PELECANUS**, *the Pelican*, in Natural History, a genus of birds, of the order anseres. There are thirty species, of which we shall notice the following: The great pelican, is sometimes of the weight of 25 pounds, and of the width, between the extreme points of the wings, of 15 feet; the skin between the sides of the upper mandible, is extremely dilatable, reaching more than half a foot down the neck, and capable of containing many quarts of water. This skin is often used by sailors for tobacco pouches, and has been occasionally converted into elegant ladies' workbags. About the Caspian and Black seas these birds are very numerous, and they are chiefly to be found in the warmer regions, inhabiting almost every country in Africa. They build in the small isles of lakes, far from the habitations of man.—The American pelican, is about the size of a goose; of this bird it is reported that it will bring large supplies of food to any disabled and diseased companion; and that the natives of the island of Assumption, by confining one near the shore, frequently induce others to make these generous presents, which are fraudulently converted to the purpose of food for the islanders.—The man-of-war bird, is small in body, but between the extremities of the wings fourteen feet in width. It is seldom seen but within the tropics, and not unfrequently is observed two hundred leagues from land. It watches the movements of fishes from a very considerable height, and pounces upon them with unfailing success, returning from its immersion with equal rapidity.—The carbo, or cormorant, nearly as large as a goose, is found in many places both of the old and the new world, and is to be met with in the northern parts of this island. These birds are shy and crafty, but frequently eat to so great an excess as to induce a species of lethargy, in which they are caught by nets thrown over them, without their making an effort to escape. They are trained by the Chinese to fish for them. By a ring placed round their necks, they are prevented swallowing what they take, and, when their pouches are filled, they unload them, and at the command of their owners renew their divings; two will be seen combining their efforts to secure a fish too large for the management of one only. When their work is finished to the employer's satisfaction, the birds have a full allotment of the spoil, for their reward and encouragement. In Macao, also these birds are thus domesticated, taking extreme delight in the exercise, and constituting a source of very considerable profit to their owners. They were formerly trained and used in the same manner in England; and Charles I. had an officer of his household, called master of the cormorants.—The Soland goose, or gannet, weighs about seven pounds, and inhabits in great numbers the northern isles of this kingdom. It is migratory, and drawn to this country by the shoals of herrings and pilchards, whose movements it watches with the most anxious vigilance. The young birds are sold in great plenty at Edinburgh, where they are frequently introduced before dinner as a stimulus to appetite. In St. Kilda it is supposed that upwards of twenty thousand of these birds are taken annually. They constitute an important article of food to the inhabitants, who, to procure both the eggs and young ones, expose themselves to the most imminent dangers on elevated and precipitous cliffs, and in several instances have fallen victims to the hardihood with which they have pursued their researches during the breeding season.

**PELECOID**, or Pelecoides, hatchet form, in Geometry, contained under the two inverted quadrantal arcs A B and A D, and the semicircle B C D. The area of the pelecoid is demonstrated to be equal to the square A C; and that again to the rectangle E B. It is equal to the square A C, because it wants of the square on the left hand the two segments A B and A D, which are equal to the two segments B C and C D, by which it exceeds it on the right hand.



**PELICAN**, in Chemistry, a kind of double glass vessel, used in distilling liquors by circulation; it consists of a cucurbit and alembic head, with two tubes bending into the cucurbit again.

**PELL, Dr. John**, an eminent English mathematician, was born at Southwick, in the county of Sussex, in 1610, and died in London in 1685, at the age of 74. He was author of numerous papers and treatises on mathematical and astronomical subjects, but none of them are now of sufficient importance to be enumerated in this place; but a complete catalogue of them may be seen in Dr. Hutton's Mathematical Dictionary.

**PELLICLE**, among Physicians, &c. denotes a thin film or fragment of a membrane.

**PEN**, a well-known instrument used in writing, the origin of which is unknown. The fountain pen is made of silver, brass, or copper, &c. and is so contrived that it will hold a considerable quantity of ink, which it discharges as the writer proceeds. The following method has been recommended for making a self-giving, or fountain pen:—The pen is made of two quills; the top one, which we shall call No. 1, and the other No. 2. When you have ready both quills like the model, take care that the top of No. 1. be made air-tight, (which we do by dropping a small piece of cobbler's wax at the bottom, and then warm it a little;) fill it nearly with ink, say about a quarter of an inch from the brim; take a small piece of cambric or muslin, (cambric answers the best,) cover the top with it so that the ink may not drop out, join both quills together, by putting No. 1. into No. 2. and the pen is ready for use. When you want to write, take the pen in your right hand, give a gentle shock on your left hand, or on a table, and the ink will run down immediately into the pen; this must be repeated every time ink is wanted. This very cheap *self-giving ink pen*, is extremely useful for reporters and persons going into the country, and also to many others, who will take delight in making use of it. The pen should be put in a little case to carry about.

PENAL LAWS, or STATUTES, having been made on many occasions, to punish or deter offenders, they ought to be construed strictly, and not be extended by equity, but the words of them may be interpreted beneficially according to the intent of the legislator.

PENALTY, is a forfeiture inflicted for not complying with the regulations of certain acts of parliament; a penalty is also annexed to secure the performance of certain covenants in a deed, articles of agreement, copartnership, &c. In a bond also for payment of money, it is usual to annex a penalty in double the amount of the obligation.

PENANCE, in our Canon Law, is an ecclesiastical punishment, chiefly adjudged to the sin of fornication.

PENCIL, an instrument used by painters for laying on their colours. Pencils are of various kinds, and made of various materials; the larger sorts are made of boar's bristles, the thick ends of which are bound to a stick, large or small according to the uses they are designed for; these, when large, are called brushes. The finer sorts of pencils are made of camels', badgers', and squirrels' hair, and of the down of swans; these are tied at the upper end with a piece of strong thread, and enclosed in the barrel of a quill. All good pencils, on being drawn between the lips, come to a fine point.

PENCIL, *Black Lead*. The common trash are made of black lead in powder, stirred in melted sulphur, and poured into the pencil-case, which is itself made of cedar; but good pencils are made of solid black lead glued on the cedar, and properly covered and finished. You may easily know by holding a pencil to the flame of a candle whether it be of the former or latter sort. The sulphur in the former will ignite and throw out a smell; black lead does neither.

PENCIL *of Rays*, in Optics, denotes a number of rays diverging from some luminous point, which, after falling upon and passing through a lens, converge again on entering the eye.

PENDANT, an ornament hanging at the ear, frequently consisting of diamonds, pearls, and other precious stones.

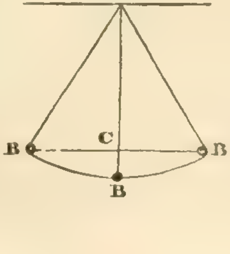
PENDANT, or *Pennant*, a sort of long narrow banner displayed from the mast-head of a ship of war, and usually terminating in two ends or points, called the swallow's-tail. It denotes that a vessel is in actual service.

*Broad* PENDANT, is a kind of flag terminating in one or two points, used to distinguish the chief of a squadron.

PENDANT, is also a short piece of rope, fixed on each side under the shrouds, upon the heads of the main and fore masts, from which it depends as low as the cat-harpings, having an iron thimble spliced into an eye at the lower end, to receive the hooks of the main and fore tackles. There are, besides, many other pendants of this latter kind, which are generally single or double ropes, to whose lower extremity is attached a block or tackle; such are the fish pendant, stay-tackle pendant, yard-tackle pendant, reef-tackle pendant, &c. all of which are employed to transmit the efforts of their respective tackles to some distant object.

*Rudder* PENDANT, is a strong rope made fast by means of a chain to a rudder. Its use is to prevent the loss of the rudder, if accidentally unshipped or disengaged from the gudgeons.

PENDULUM, in Mechanics, denotes any heavy body so suspended that it may vibrate, or swing backwards and forwards, about some fixed point, by the action of gravity. The vibrations of a pendulum are called its *oscillations*, the time of each being counted from the time of its descent from the highest point on one side, till it attains the highest point on the opposite side. A pendulum, therefore, is a heavy body B, suspended upon and moving about some fixed point at A as a centre. Here the point A is called the *centre of motion*, or *of suspension*, and the line P Q parallel to the horizon, the *axis of oscillation*, and that point in the body B, into which, if all the matter of the body was condensed, so as still to perform its oscillations in the same time, is called the centre of oscillation; and the distance of this point from the point of suspension, is accounted the *length* of the pendulum. See *Centre of Oscillation*.—Pendulums receive particular denominations according to the materials of which they are composed or the purposes they are intended to answer; for an account of which, see the subsequent part of this article; we shall here confine our remarks to the theory of the simple pendulum.



*Simple* PENDULUM, theoretically considered, is a single weight attached to a string supposed to be devoid of gravity, and oscillating freely, without resistance either from friction or the air.

*Properties of the Simple Pendulum thus constituted, and vibrating in small circular Arcs.* 1. The vibrations of the same pendulum, or of different pendulums of the same length, and in the same place, in very small arcs of circles, are always performed in the same time. 2. The velocity of the bob, in the lowest point of the arc, will be very nearly as the length of the chord of the arc which it describes in its descent. 3. The times of vibration of different pendulums are, to each other, as the square roots of their length. Or their lengths are as the squares of the number of vibrations performed in the same time. 4. On the supposition above made, *viz.* that there is neither friction nor resistance opposed to the motion of the pendulum, that motion would be perpetual, that is, the force which it acquires in its descent would carry it up to the same height on the opposite side, which would be again repeated in its descent, and thus it would continue to oscillate constantly through the same arc, and consequently its vibrations uniform and perpetual. But as it is impossible to divest it of these two retarding forces, it is obvious, as well from theory as practice, that without the application of some external force, the vibrations will be shortened in every ascent, and the motion of the pendulum ultimately cease. 5. The time of vibration in a circular arc of any sensible magnitude, is expressed by the following formulæ:

$$\text{time} = p\sqrt{\frac{d}{4g}} \times \left\{ 1 + \frac{1^2 a}{2^2 d} + \frac{1^2.3^2.a^2}{2^2.4^2.d^2} + \frac{1^2.3^2.5^2.a^3}{2^2.4^2.6^2.d^3} + \&c. \right\}$$

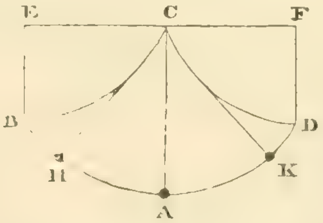
Where $d = 2$ A B, or twice the length of the pendulum, $a =$ C B the versed sine of half the arc of vibration, $g = 16\frac{1}{12}$ half the force of gravity, and $p = 3{\cdot}1416$ the circumference of a circle whose diameter is 1. 6. When $a$ is very small, as in the preceding cases, then writing $2l$ instead of $d$, and omitting all the terms in the series beyond the second as being inconsiderable, we shall have

$$\text{time} = p\sqrt{\frac{l}{2g}} \times \left(1 + \frac{a}{g\,l}\right) = \frac{p}{g\,l}\sqrt{\frac{l}{2g}} \times (8l + a.)$$

7. Or instead of using the versed sine of the half arc, we introduce the degrees in that arc, the expression becomes

$$\text{time} = p\sqrt{\frac{l}{2g}} \times \left(1 + \frac{d^2}{5231}\right).$$

*Properties of Pendulums vibrating in cycloidal Arcs.*—1. It is a property of the cycloid that its evolute is a cycloid, similar and equal to the former. If therefore a pendulum be suspended from C, the point of concurrence of two equal inverted semicycloidal cheeks, and be made to vibrate between them, the bob will describe the cycloidal arc H A K, and the properties of a pendulum thus suspended are: 2. The time of oscillation in all arcs, whether great or small, are performed in the same time. 3. The time of vibration in any arc, is to the time in which a heavy body would fall by the force of gravity through half the length of the pendulum; as the circumference of a circle is to its diameter. Now by the laws of falling bodies $\sqrt{\frac{l}{2g}} =$ the time of a body falling through $\frac{1}{2}l$, or $\frac{1}{2}$ C A; therefore putting $p = 3{\cdot}1416$, the circumference of a circle whose diameter is 1, we have as $1'' : p :: \sqrt{\frac{l}{2g}} : p\sqrt{\frac{l}{2g}}$ the



time of vibration of a pendulum whose length is $l$. 4. In this formula, as well as in those given above, the time of vibration depends not only on the length of the pendulum, but also on the value of $g$, which differ in different latitudes; and consequently the lengths of the pendulum designed to vibrate any proposed number of times in a second, in any place, must be regulated by the value of $g$, or by the force of gravity at that place. 5. The value of $g$ in the latitude of London is $16\frac{1}{12}$ feet, or 193 inches, which being substituted for $g$ in the expression $p \sqrt{\frac{l}{2g}} = 1''$, gives $l = 39{\cdot}11$, or $39\frac{1}{9}$ inches for the length of the seconds' pendulum, which is extremely near the true length as determined from accurate experiments, which shew it to be about $39\frac{1}{8}$ inches. 6. From the above formula may also be found the force of gravity in any particular place, the length of the seconds' pendulum being previously found from experiment; for, squaring the above, we have $\frac{p^2 l}{2g} = 1$, or $g = \frac{1}{2} p^2 l$, the descent of a heavy body in one second, in terms of the length of the seconds' pendulum; and this is a much more accurate method of finding the force of gravity, than any other which depends simply on experiments. 7. In the simple pendulum, vibrating in very small arcs, we found that the time of one vibration was nearly $= p \sqrt{\frac{l}{2g}} \times \left(1 + \frac{a}{8l}\right)$, where $a$ is the versed sine of half the arc of vibration, whereas in a cycloid the time is simply $p = \sqrt{\frac{l}{2g}}$, and therefore the time lost each vibration in the former case is $\frac{ap}{8l} \times \sqrt{\frac{l}{2g}}$, or, estimating by the degrees of the arc, it is $\frac{D^2 p}{52524} \times \sqrt{\frac{l}{2g}}$; and hence we may compute how much the pendulum must be shortened in the former case to make its vibrations correspond with one vibrating as in the latter case. 8. And since the length of the pendulum varies in different latitudes in consequence of the variation in the force of gravity, on this principle is computed the following Table, which shews the length of the seconds' pendulum for every five degrees of latitude from the equator to the pole.

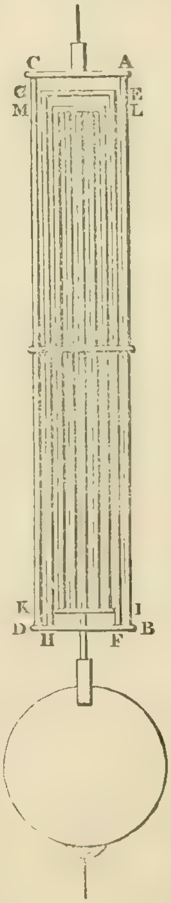
| Deg. of Latitude. | Length of Pendulum. | Deg. of Latitude. | Length of Pendulum. |
|---|---|---|---|
| 0 | 39·027 | 50 | 39·126 |
| 5 | 39 029 | 55 | 39·142 |
| 10 | 39·032 | 60 | 39·158 |
| 15 | 39·036 | 65 | 39·168 |
| 20 | 39 044 | 70 | 39 177 |
| 25 | 39 057 | 75 | 39 187 |
| 30 | 39·070 | 80 | 39·191 |
| 35 | 39·084 | 85 | 39 195 |
| 40 | 39 097 | 90 | 39·197 |
| 45 | 39·111 | | |

The foregoing laws, &c. of the motion of pendulums, cannot strictly hold good, unless the thread that sustains the ball be void of weight, and the gravity of the whole ball be collected into a point. In practice, therefore, a very fine thread, and a small ball, but of a very heavy matter, are to be used. But a thick thread and a bulky ball disturb the motion very much; for in that case, the simple pendulum becomes a compound one; it being much the same thing, as if several weights were applied to the same inflexible rod in several places.

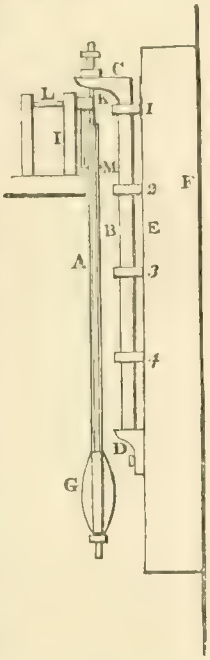
Having said thus much with regard to simple pendulums, it remains only to offer a few remarks on the nature of compound pendulums, as applied to clocks and other machines where uniform motion is required. We have seen above, that pendulums in different latitudes require to be of different lengths, in order that they may perform their vibrations in the same time; but besides this, there is another irregularity in the motion of a pendulum in the same place, arising from the different degrees of temperature. Heat expanding and cold contracting the rod of the pendulum, a certain small variation must necessarily follow in the time of its vibration; to remedy which defect various methods have been invented for constructing what are commonly called *compensation pendulums*, or such as shall always preserve the same distance between the centre of oscillation and the point of suspension; but of these we can only describe one or two of the most approved construction.

*Compound* or *Compensation* PENDULUMS, have received different denominations from their form and materials, as the *gridiron pendulum, mercurial pendulum, lever pendulum*, &c.

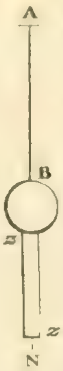
*Gridiron* PENDULUM. Instead of one rod, this pendulum is composed of any convenient odd number of rods, as five, seven, or nine; being so connected, that the effect of one set of them counteracts that of the other set; and therefore, if they are properly adjusted to each other, the centres of suspension and oscillation will always be equidistant. The two outer rods, A B, C D, which are of steel, are fastened to the cross pieces A C, B D, by means of pins. The next two rods, E F, G H, are of brass, and are fastened to the lower bar B D, and to the second upper bar E G. The two following rods are of steel, and are fastened to the cross bars E G and I K. The two rods adjacent to the central rod being of brass, are fastened to the cross pieces I K and L M; and the central rod, to which the ball of the pendulum is attached, is suspended from the cross piece L M, and passes freely through a perforation in each of the cross bars I K, B D. From this disposition of the rods, it is evident, that by the expansion of the extreme rods, the cross piece B D, and the two rods attached to it, will descend; but since these rods are expanded by the same heat, the cross piece E G will consequently be raised, and therefore also the two next rods; but because these rods are also expanded, the cross bar I K will descend; and by the expansion of the two next rods, the piece L M, will be raised a quantity sufficient to counteract the expansion of the central rod. Whence it is obvious, that the effect of the steel rod is to increase the length of the pendulum in hot weather, and to diminish it in cold weather, and that the brass rods have a contrary effect upon the pendulum. The effect of the brass rods must, however, be equivalent not only to that of the steel rods, but also to the part above the frame and spring which connects it with the cock, and to that part between the lower part of the frame and centre of the ball.



Another excellent contrivance, for the same purpose, is described in a French author on clock-making. It was used in the north of England by an ingenious artist, about fifty years ago. This invention is as follows:—A bar of the same metal with the rod of the pendulum, and of the same dimensions, is placed against the back part of the clock-case; from the top of this a part projects, to which the upper part of the pendulum is connected by two fine pliable chains or silken strings, which just below pass between two plates of brass, whose lower edges always terminate the length of the pendulum at the upper end. These plates are supported on a pedestal, fixed to the back of the case. The bar rests upon an immoveable base, at the lower part of the case; and is inserted into a groove, by which means it is always retained in the same position. From this construction, it is evident that the extension or contraction of this bar, and of the rod of the pendulum, will be equal, and in contrary directions. For, suppose the rod of the pendulum be expanded any given quantity by heat, then, as the lower end of the bar rests upon a fixed point, the bar will be expanded upwards, and raise the upper end of the pendulum just as much as its length was increased; and hence its length below the plates will be the same as before. Of this pendulum, somewhat improved by Mr. Crosthwaite, watch and clock maker, Dublin, we have the following description. "A and B are two rods of steel forged out of the same bar, at the same time, of the same temper, and in every respect similar. On the top of B is formed a gibbet C; this rod is firmly supported by a steel bracket D, fixed on a large piece of marble E, firmly set into the wall F, and having liberty to move freely upwards, between cross staples of brass 1, 2, 3, 4, which touch only in a point in front and rear, (the staples having been carefully formed for that purpose,) to the other rod is firmly fixed by its centre the lens G, of twenty-four pounds weight, although it should, in strictness, be a little below it. This pendulum is suspended by a short steel spring on the gibbet at C; all which is entirely independent of the clock. To the back of the clock-plate, I, are firmly screwed two cheeks nearly cycloidal at K, exactly in a line with the centre of the verge L. The maintaining power is applied by a cylindrical steel stud, in the usual way of regulators, at M. Now, it is very evident, that any expansion or contraction that takes place in either of these exactly similar rods, is instantly counteracted by the other; whereas in all compensation pendulums, composed of different materials, however just the calculation may seem to be, that can never be the case, as not only different metals, but also different bars of the same metal, that are not manufactured at the same time, and exactly in the same manner, are found, by a good pyrometer, to differ materially in their degrees of expansion and contraction, a very small change affecting one and not the other."——The expansion and contraction of straight-grained fir wood lengthwise, by change of temperature, is so small, that it is found to make very good pendulum rods. The wood called sapadillo is said to be better. There is good reason to believe, that the previous baking, varnishing, gilding, or soaking of these woods in any melted matter, only tends to impair the property that renders them valuable. They should be simply rubbed on the outer side with wax and a cloth. In pendulums of this construction, the error is greatly diminished, but not taken away. As pendulums are expanded by heat, and contracted by cold, and the time of their vibration is thereby affected, various expedients have been attempted, to remedy this defect, the most important of which is the gridiron pendulum.



The *Mercurial* Pendulum was the invention of the ingenious Mr. Graham, in consequence of several experiments relating to the materials of which a pendulum might be formed, in 1715. Its rod is made of brass, and branches towards its lower end, so as to embrace a cylindrical glass vessel 13 or 14 inches long, and about 2 inches in diameter; which being filled about 12 inches deep with mercury, forms the weight or ball of the pendulum. If upon trial the expansion of the rod be found too great for that of the mercury, more mercury must be poured into the vessel; if the expansion of the mercury exceeds that of the rod, so as to occasion the clock to gain with an increase of temperature, some mercury must be taken out of the vessel, in order to shorten the column. And thus may the expansion and contraction of the quicksilver in the glass be made exactly to balance the expansion and contraction of the pendulum rod, and thus preserve the distance between the centre of oscillation and the point of suspension invariably the same.



Reid's *Compensation* Pendulum, is a recent invention of Adam Reid of Woolwich, the construction of which is as follows:— A N is a rod of wire, and Z Z a hollow tube of zinc, which slips on the wire, being stopped from falling off by a nut N, on which it rests; and on the upper part of this cylinder of zinc rests the heavy ball B; now the length of the tube Z Z being so adjusted to the length of the rod A N, that the expansions of the two bodies shall be equal with equal degrees of temperature; that is, by making the length of the zinc tube to that of the wire, as the expansion of wire is to that of zinc, it is obvious that the ball B will in all cases preserve the same distance from A; for just so much as it would descend by the expansion of the wire downwards, so much will it ascend by the expansion of the zinc upwards, and consequently its vibrations will in all temperatures be performed in equal times.

*On the method of determining the Figure of the Earth by the Pendulum.*—The method of determining the figure of the earth by means of the Pendulum, depends upon the variation of gravity at the earth's surface. This subtile and pervading power tends to communicate to bodies exposed to its influence equal velocities in equal times. One of the modifications of this action is the oscillation of the pendulum, which is of longer or shorter duration, according to the energy of the attractive force, and the square root of the length of the pendulum. If the earth were an exact sphere, destitute of the motion of rotation, and possessing the same density throughout its whole mass, the force of gravity, by which bodies at its surface are drawn towards the centre, would be uniform, and invariable in every latitude. But the elliptical form of the earth destroys this uniformity, and causes the attractive force at the poles to preponderate over that at the equator. This inequality in the force, by which bodies at the surface of the earth retain their positions, is augmented by the diurnal rotation, which, by its centrifugal tendency, impresses a greater disposition on bodies to recede from the centre of the earth at the equator than at the poles, where its effects cease to be felt. By the joint operation of these two causes, one of which acts with a force proportional to the square of the sine of the latitude, a sensible difference ought to be observed in the velocity acquired by heavy bodies, in falling through the same space, as we advance from the equator to the poles. An important relation between the time of the vibration of a pendulum, and that of the descent of a heavy body, according to which the lengths of pendulums, vibrating synchronously, are directly as the force of gravity, enables us to submit this conclusion to the test of experiment. Newton long ago demonstrated, that if the earth were perfectly homogeneous, the same fraction, *viz.* $\frac{1}{230}$, would express both the compression of the terrestrial ellipsoid, and the increase of gravity from the equator to the poles. This conclusion, which was deduced from the supposition of an uniform density, was afterwards modified, with singular address, by Clairaut, who shewed, that the two fractions expressing the compression, and the increase of gravity, though not exactly equal, must always together amount to $\frac{2}{230}$. Assuming the compression, therefore, to be equal to $\frac{1}{312}$, the increase of gravity from the equator to the poles, or the indication of that increase, as given by the length of the pendulum, should be $\frac{2}{230} - \frac{1}{312}$, or $\frac{1}{182}$ nearly. The correctness of this conclusion, if not completely established, is, at least, to a certain extent, confirmed, by the experiments which have been made with the pendulum in different latitudes. La Place having selected fifteen of the best of these observations, and applied to them the necessary corrections, on account of the resistance of the air, difference of temperature, and elevation above the level of the sea, deduced the following results, in which the length of the pendulum at Paris is considered to be unity.

The following results indicate obviously an increase of the force of gravity from the equator towards the poles. La Place has shewn that, in whatever way they are combined, it is impossible to avoid an error of less than ·00018, on the hypothesis of the variation of gravity at the surface of the earth increasing as the squares of the sines of the latitude from the equator to the poles.

| Latitude. | Length of the Seconds Pendulum. | Names of the Observers. | Places of Observation. |
|---|---|---|---|
| Equator | ·99669 | Bouguer | Peru |
| 9° 32′ 56″ | ·99689 | Ditto | Portobello |
| 11 55 39 | ·99710 | Gentil | Pondicherry |
| 18 0 0 | ·99745 | Campbell | Jamaica |
| 18 27 0 | ·99728 | Bouguer | Petit Grave |
| 34 7 15 | ·99877 | La Caille | Cape G. H. |
| 43 35 45 | ·99950 | Darquier | Toulouse |
| 48 12 48 | ·99077 | Liesganig | Vienna |
| 48 50 0 | 1·00000 | Bouguer | Paris |
| 50 58 0 | 1·00006 | Zach | Gotha |
| 51 30 0 | 1·00018 | | London |
| 58 14 53 | 1·00074 | Mallet | Petersburgh |
| 59 56 24 | 1·00101 | Ditto | Ponoi |
| 66 48 0 | 1·00137 | Grischow | Arensberg |
| 67 5 0 | 1·00148 | Maupertuis | Tornea |

The expression for the ellipticity, which connects best the different equations of condition, is $\frac{1}{333{\cdot}78}$, and this is a result which accords in a very remarkable manner with the compression deduced from the measures of the French mathematicians in France, and at the equator. It may be inferred from these experiments with the pendulum, that the compression of the earth is greater than is compatible with the supposition of an uniform density. The same anomalies, too, which are discernible in the measurement of a degree of the meridian, and which are undoubtedly owing to the dissimilar structure of the globe, may be traced in the results of these experiments. The beautiful property of the pendulum, first discovered by Huygens, that the centre of oscillation and the point of suspension, are interchangeable with each other, and which has been so happily applied by Captain Kater, to determine the length of the seconds' pendulum, renders this mechanical contrivance infinitely better fitted to ascertain the true figure of the earth, than the complicated methods which were formerly employed for the same purpose. The facility with which the observations may be made, and the certainty of the results with which they are attended, may be expected to furnish much interesting information, not only with respect to the general form of the globe, but also with respect to its structure and composition in particular situations.

**PENELOPE**, a genus of birds, of which there are four species, of the order gallinæ.

**PENETRABILITY**, the capability of being penetrated.

**PENETRALE**, a sacred room or chapel in private houses, which was set apart for the worship of the household gods among the old Romans. The *penetralia* of the temples contained the images of the gods, and were sacred to the performance of particular rites.

**PENETRATION**, is used principally to denote the forcible entry of one solid body within another by means of a projectile motion, communicated to the former, which enables it to displace those parts of the latter with which it comes in contact. Or, the penetration may be otherwise produced by the action of some percussive force acting upon one of the bodies when in contact with the other; these two cases, however, differ rather in circumstances than in principle, and therefore in the slight sketch we shall give of this subject, we shall consider the penetrating body to be projected with a certain velocity, and impinging upon the fixed body in a direction perpendicular to its surface. This is a subject of considerable importance in military and naval gunnery, and has been accordingly treated of by different writers on these subjects; Dr. Hutton in particular has made several experiments on different substances, and with different charges of powder, and different weight of shot, in order to procure data from which the penetration in other cases may be determined. The mean results of the most accurate of his experiments, as given in vol. iii. of his Tracts, are stated in the next column:

| Velocity in feet. | Substances. | Diam. of iron shot in inches. | Penetration. |
|---|---|---|---|
| 1600 | Elm | 1·96 | 20 inch. |
| 1200 | Ditto | 1·96 | 15 |
| 1500 | Ditto | 2·78 | 30 |
| 1060 | Ditto | 2·78 | 16 |
| 1200 | Oak | 5·04 | 34 |
| 1300 | Earth | 5·55 | 15 feet. |

In these experiments the gun was placed so near the object, that the initial velocity of the ball was not changed, and the penetration was made lengthways of the timber, which in the first four cases was sound elm, cut off near the root of the tree; the other two experiments were made by Robins, and given by that author, with some others, in his tract on Gunnery. The first two experiments, with the velocity 1600 and 1200 feet, give 20 and 15 inches for the penetration, being precisely in the ratio of the two velocities; but this ratio does not obtain in the next two experiments; in fact, it is pretty obvious that this cannot be the case, unless the resisting force of the wood was uniformly the same throughout, which cannot be; its density about the penetrating body increasing every instant, in consequence of the parts forced in by the ball, which accounts for the results as deduced by Dr. Hutton on this hypothesis not agreeing with each other. It is ascertained by a very rigid formula, that the depth penetrated is as the density and diameter of the ball, and the square of the velocity, divided by the strength, or resisting force, of the matter or obstacle; so that if equal balls be discharged against the obstacle, the depths will be as the squares of the velocities.

**PENGUIN**, in Ornithology, a genus of birds, of the order of anseres, of which there are twelve species.

**PENINSULA**, is a tract of land joined to the continent by a narrow neck called isthmus.

**PENITENCE**, *Religious Orders of*, consisting of either converted debauchees and reformed prostitutes, or of persons who devote themselves to the office of reclaiming them; as, the *Order of Penitence of St. Magdalen*, founded in 1272, &c. Since 1616, none have been admitted but maids, although the congregations still retain their ancient name.

**PENNATULA**, or **Sea Pen**, a genus of zoophyte, which, though it swims about freely in the sea, approaches near to the gorgonia. This genus has a bone along the middle of the inside, which is its chief support; and this bone receives the supply of its osseous matter by the same polype-mouths that furnish it with nourishment. Linnæus reckon seven species.

**PENNY**, an English copper coin, the 12th part of a shilling.

**PENNYWEIGHT**, the 20th part of an ounce Troy. This weight derived its name from being exactly the weight of an ancient English silver penny.

**PENSTOCK**, is a sluice or floodgate, serving to retain, or let go at pleasure, the water of a millpond. The following is a description of a pentrough and stock for equalizing the water falling on water wheels, by George Quayle, Esq. To insure a regular supply of water on the wheel, and to obviate the inconveniences arising from the usual mode of delivering it from the bottom of the pentrough, this method is devised, of regulating the quantity delivered by a float, and taking the whole of the water from the surface. Section of the pentrough:—A, fig. 1, the entrance of the water; B, the float, having a circular aperture in the centre; in which is suspended C, a cylinder, running down in the case E below the bottom of the pentrough. This is made water-tight at the bottom of the pentrough at F, by a leather collar placed between the two plates, and screwed down to the bottom. The cylinder is secured to the float, so as to follow its rise and fall; and the water is admitted into it through the opening in its side, and there, passing through the box or case E, rises and issues at G on the wheel. By this means, a uniform quantity of water is obtained at G; which quantity can be increased or diminished by the assistance of a small rack and pinion attached to the cylinder, which will raise or depress the cylinder above or under the water-line of the float; and, by raising it up to the top, it stops the water entirely, and answers the purpose of the common shuttle. This pinion is turned by the handle H, similar to a winch handle, and is secured from running down by a ratchet wheel at the opposite end of the pinion axis. K and L are two upright rods, to preserve the perpendicular rise and sinking of the float, running through the float, and secured at the top by brackets from the sides. M, a board let down across the pentrough, nearly to the bottom, to prevent the horizontal impulse of the water from disturbing the float. Fig. 2, a transverse section, shewing the mode of fixing the rack and pinion, and their supports, on the float. The rack is inserted into a piece of metal running across the cylinder near the top. That the water may pass more freely when nearly exhausted, the bottom of the cylinder is not a plane, but is cut away so as to leave two feet, as at C, fig. 1. The float is also kept from lying on the pentrough bottom by four small feet, so that the water gets under it regularly from the first. Fig. 3, an enlarged view of the cylinder, shewing the rack and ratchet wheel, with the click, and one of the openings on the side of the cylinder; the winch or handle being on the opposite side, and the pinion, by which the rack is raised, being enclosed in a box between them. *See* SLUICE.

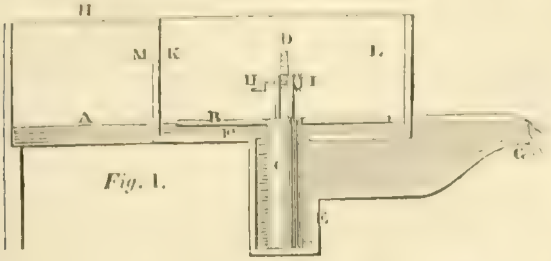


Fig. 1.

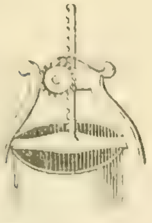


Fig. 3.

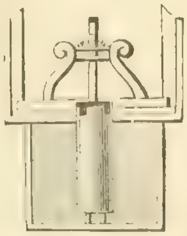
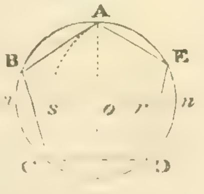


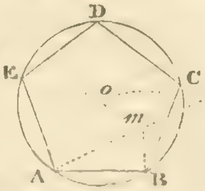
Fig. 2.

**PENTAGON**, (from *five* and *angle*,) in Geometry, is a figure of five angles, and consequently also of five sides, and when these are both equal, it is called a regular pentagon, but otherwise it is irregular. The angle at the centre of a pentagon is 72°, and the angle of its sides 144°. The area of a pentagon, whose side is one, is 1·7204774; consequently, when the side is $s$, the area $= s^2 \times 1·7204774$.

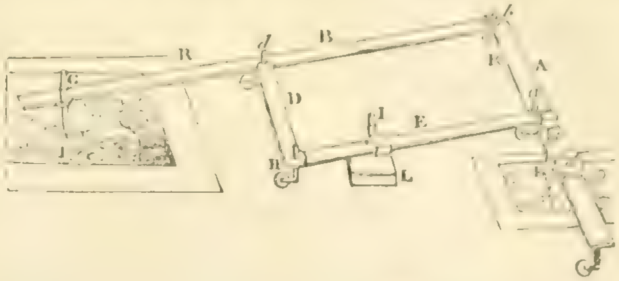
*To inscribe a Pentagon in a given Circle.*—Draw the diameters, A $p$, $n$ $m$ at right angles to each other, and bisect the radius $o$ $n$ in $r$. From the point $r$, with the distance $r$ A, describe the arc A $s$, and from the point A, with the distance A $s$, describe the arc $s$ B. Join the points A, B, and the line A B being carried five times round the circle, will form the pentagon required.



*To describe a Pentagon on a given Line.*—Make B $m$ perpendicular to A B, and equal to one half of it. Draw A $m$, and produce it till the part $m$ $n$ is equal to B $m$. From A and B, as centres with the radius B$n$, describe arcs cutting each other in $o$. And from the point $o$, with the same radius, or with $o$ A, or $o$ B, describe the circle ABCDE. Apply the line A B five times round the circumference of this circle, and it will form the pentagon required.—*Note.* If tangents be drawn through the angular points A B C D E, a pentagon circumscribing the circle will be formed; and if the arcs be bisected, the circle will be divided into ten parts, which answers to a decagon, and is thus readily constructed.



**PENTAGRAPH**, or PARALLELOGRAM, an instrument whereby designs of any kind may be copied in what proportion you please, without being skilled in drawing. A pentagraph is composed of four bars, A B D E, usually of brass; the bar A is jointed to B at $b$ about the middle, and at $a$ it is connected with E: the bar B is the same length as A, and at $d$ is jointed to the bar D, whose end is connected with the end of E; these four bars form a parallelogram; thus, $b\,a$ = D, and $b\,d$ = E. To the other end of the bar A, a tube F is soldered, through which



a pointed brass rod $e$, called the tracer, is put; the end of the bar B has a slider G upon it, which has a tube similar to F; another slider, I, of the same kind, is mounted on the bar B. These sliders have screws, by which they can be fixed at any distance. Under each of the joints of the base, a small tube is fixed, in the bottom of which is a small caster, as H, which makes the instrument run easily on the table. When the instrument is used, the two sliders, G I, must be set exactly in a line with the tube F: when it is required to make a copy of a drawing of the same size, the sliders must be set, so that from F to I is the same distance as from I to G; the tube I must then have a wire put through it, whose lowest end is fast screwed to a heavy leaden weight L, this must have three sharp points in the under side, so that when it is set on the table it may not be liable to move; then, if a design or drawing is laid under the tube F, and the point of the tracer drawn over the lines of it, the point of the pencil at G will describe a similar figure. If the drawing is to be reduced to one-half of the size, the weight must be put to the slider G, and the pencil into I, without moving either slider; then the distance from the tracer to the fixed point or weight L, is twice the distance of the pencil to the weight. The rule for setting the sliders for any proportion, is as the distance between the tracer $e$, and the the fixed point L, is to the distance between the pencil G and the same; so is the length of any line described by the tracer, to the length of the line at the same time described by the pencil. To avoid the trouble of measuring these distances each time, the bars B and D are divided into ten or twenty of the most common proportions, by which divisions the sliders are to be fixed. When the machine is used, a fine line, R R, is put through rings in the cocks $b$ $d$, and tied to the pencil; the other end has a loop to be hooked over the thumb of the operator, by pulling which he can raise the pencil at D, when he does not wish it to mark.

**PENTAMETER**, in ancient poetry, a kind of verse consisting of five feet, or metres; whence the name. The two first feet may be either dactyls or spondees, at pleasure; the third is always a spondee, and the two last anapests: such is the following verse of Ovid:—

1 2 3 4 5
*Carmini | bus ri | res tem | pus in o | mne meis.*

A pentameter verse, subjoined to an hexameter, constitutes what is called elegiac.

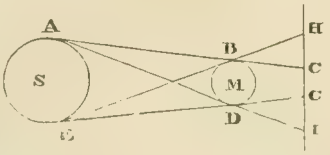
**PENTANDRIA**, in Botany, one of Linnæus's class of plants, the fifth in order; the characters of which are, that all the plants comprehended in it have hermaphrodite flowers, with five stamina, or male parts, in each; they are subdivided into orders, which are denominated monogynia, digynia, trigynia, &c. according as there are one, two, or three, &c. pistils, or female parts, in each flower.

**PENTAPETES**, a genus of the decandria order, in the monadelphia class of plants, and in the natural method ranking under the 37th order, columniferæ.

**PENTHORUM**, a genus of the pentagynia order, in the pentandria class of plants. There is one species.

**PENTSTEMON**, a genus of the didynamia angiospermia class and order. There are two species.

**PENUMBRA**, in Astronomy, a faint or partial shade observed between the perfect shadow and the fall of light in an eclipse. This arises from the magnitude of the sun, for were he only a luminous point, the shadow would be every where perfect; but in consequence of his diameter, it happens, that a place, which though not illuminated by the whole body of the sun, may notwithstanding receive a part of his rays. This may be illustrated as follows: let S represent the sun and M the moon, then it is obvious, since luminous rays proceed from every part of the sun's disc, there will be no part of the shadow in which the light will be totally intercepted, except that included within the rays proceeding from the extreme edges of the sun and moon A B C, and E D C, the other part of the shadow, *viz.* from C to H, and I experiencing only a partial interception, and consequently in those parts a faint light will be observed, proceeding from the darkest shades at C, diminishing both ways to H and I, where it is lost in perfect light. Penumbras must be constant attendants of all eclipses whether of the sun, moon, or planets, primary or secondary; but with us they are most obvious in eclipses of the sun, which is the case above alluded to.



**PEPLIS**, a genus of the monogynia order, in the hexandria class of plants, and in the natural method ranking under the 17th order, calycanthemæ. There are two species, creeping plants.

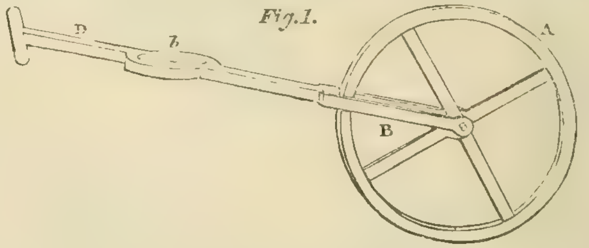
**PEPPER**, in Natural History, an aromatic berry, of a hot dry quality, chiefly used in seasoning. We have three kinds of pepper at this time in use in the shops; the black, the white, and the long pepper. Black pepper is the fruit of a plant of the diandria trigynia class, without any flower petals; the fruit itself is roundish and rugose, and disposed in clusters; it is brought from the Dutch settlements in the East Indies. The common white pepper is factitious, being prepared from the black. The long pepper is a dried fruit of about an inch, or an inch and a half in length, and about the thickness of a large goose quill; it is of a brownish gray colour, cylindrical in figure, and said to be produced on a plant of the same genus. Pepper is principally used by us in food to assist digestion; but the people in the East Indies esteem it as a stomachic, and drink a strong infusion of it in water by way of giving them an appetite; they have also a way of making a fiery spirit of fermented fresh pepper with water, which they use for the same purpose. They have also a way of preserving the common and long pepper in vinegar, and eating them afterwards at meals.

**Pepper** *Water*, a liquor prepared in the following manner, for microscopical observations: Put common black pepper grossly powdered, into an open vessel, so as to cover the bottom of it half an inch thick, and put to it rain or river water, till it covers it an inch; shake or stir the whole well together at the first mixing, but never disturb it afterwards; let the vessel be exposed to the air uncovered; and in a few days there will be seen a pellicle or thin skin swimming on the surface of the liquor looking of several colours. This is a congeries of multitudes of small animals: and being examined by the microscope, will be seen all in motion; the animals at first sight are so small as not to be distinguishable, unless to the greatest magnifiers; but they grow daily till they arrive at their full size. Their numbers are also continually increasing, till the whole surface of the liquor is full of them, to a considerable depth. When disturbed, they will sometimes all dart down to the bottom, but they soon afterwards come up to the surface again. The skin appears soonest in warm weather, and the animals grow the quickest; but in the severest cold it will succeed, unless the water freezes. About the quantity of a pin's head of this scum, taken up on the nib of a new pen, or the tip of a hair pencil, is to be laid on a plate of clear glass; and if applied first to the third magnifier, then to the second, and finally to the first, will shew the different animalcules it contains of several kinds and shapes, as well as sizes.

**PEPPERMINT**, is a British plant which grows in watery places, and is cultivated chiefly on account of an oil and distilled water which is prepared from it. This is the strongest and most aromatic of all the mints, and on this account is more used in medicine than any other species. When distilled with water, it yields a considerable quantity of essential oil, of a pale greenish yellow colour. The well-known liquor, called peppermint water, prepared from this plant, is an excellent stomachic; but is too often used in cases of impaired appetite, and for the relief of various imaginary complaints.

**PERAMBULATOR**, in Surveying, an instrument for measuring distances, called also pedometer, way-wiser, and surveying wheel. The figs 1, 2, and 3 represent a perambulator;

*Fig.1.*



A, fig. 1, is a wheel of mahogany, tired with iron, and made very strong; its circumference must be exactly ninety-nine inches, or half a pole. This is placed so as to turn round in an opening cut in the piece B D, which forms the frame. In the arm B, a groove is cut from the centre of the wheel to the dial *b*; the end of the spindle comes through the wood into this groove, and has a small crown wheel of eight feet upon it. This works another wheel of eight teeth, fixed on a long spindle, which conveys motion from the wheel beneath to the dial *b*. The groove containing this spindle has a slip of wood screwed over it, to keep out dirt, &c.; and the end of this spindle has a square hole in it, into which is put the square end of the spindle *a*, fig. 2. This has an endless screw *d* upon it, which works a worm wheel *e* of twenty-four teeth, having a pinion of twelve beneath it, and below this has a wheel *f* of thirty-six. The pinion works the wheel *g* of forty; and the wheel *f* turns the pinion *h* of twelve, whose spindle carries the short hand of the dial, fig. 3. The arbour of the wheel *g* comes up through the dial, and has the hand F, fig. 3 on it; as also a pinion of eight, which turns *g* of sixty-four. In the arbor of the wheel *h*, is a pinion of six, taking into *k* of seventy-two; this is here supposed to be half broken away, to shew the wheels beneath. The spindle of this is hollow, and is put over the arbour of the wheel *g*, and carries the hand G; fig. 2, H H H H are four pillars, by which the two plates forming the frame for the wheels are held together. The wheel *g*, fig. 2 is not fixed fast to its spindle, but is held between a brass plate, and another beneath; the friction of these causes the wheel to turn the hand, and at the same time leaves the hand at liberty to be set without moving the wheels. The plate has a pin fixed in it: which pin takes against a projecting part of the handle of the hammer *m*, so as to lift it up when the plate is turned, and let the spring *p* through *w* against the bell K. When any distance is to be measured by this machine, the operator takes hold of the handle, and wheels it along in as straight a line as he can. The circumference of the wheel being ninety-nine inches (or half a pole), and the two wheels in the piece being equal, the screw *d*, fig. 2, will turn once in each turn of the great wheel, or twice for

*Fig.2.*

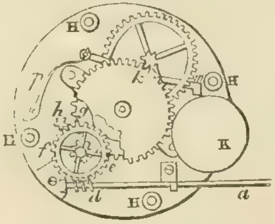
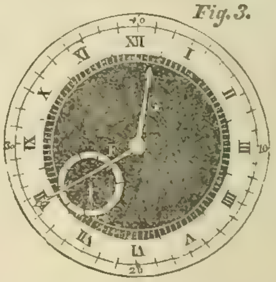


*Fig.3.*



every pole the machine is wheeled. This screw must be so cut that the great wheel must turn twenty-four times for one turn of the wheel *e*, and also the wheel *f* on the same spindle as this must turn a pinion *h* of one-third of its number of teeth. The short hand on the dial which it carries will for every revolution require eight turns of the great wheel, = four poles, = one chain. The circle is divided into one hundred parts each = one link. The pinion of twelve on the arbor of the wheel *e*, turning once for twenty-four turns of the great wheel, makes the wheel *g* require for each revolution eighty turns of the great wheel, or for the machine to be wheeled ten chains (or turns of the short hand) = 40 poles (as the circle of its hand is divided), = one furlong; and at each revolution of this wheel the hammer *m* will strike the bell K. The pinion of eight on the arbor of the wheel *g*, works *h* of sixty-four; and its pinion *i*, turns K of seventy-two, the result of which will be, that the hand on the spindle of *k* will require for each revolution 7,680 turns of the great wheel, or for the machine to be wheeled 3,840 poles, = 960 chains or turns of the short hand, = 96 furlongs or turns of the hand F and strokes on the bell, = 12 miles, as the dial is divided.

PERCA, *Perch*, a genus of fishes of the order thoraci.

PERCH, in Land Measure, the 40th part of a square rood, containing 30¼ square yards.

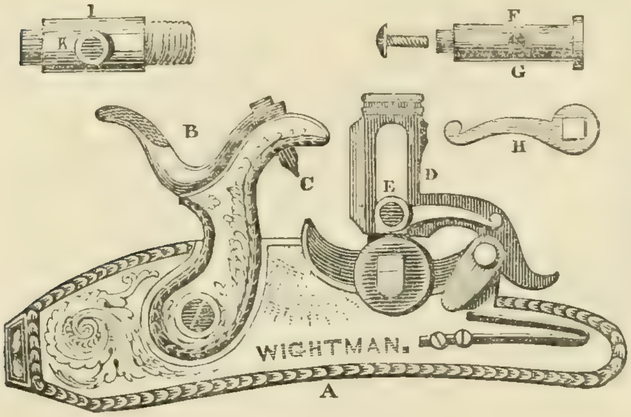
Perch, is also sometimes used as a measure of length, being equal to 5½ yards, or 16½ feet, and is otherwise called a rod or pole.

PERCUSSION, in Mechanics, the striking of one body against another, or the shock arising from the collision of two bodies. This is either direct or oblique. *Direct* Percussion, is when the impulse takes place in a line perpendicular to the plane of impact. *Oblique* Percussion, is that which takes place in any direction not perpendicular to the plane of impact.

The *Theory* of Percussion, says Barlow, has engaged the attention of philosophers, particularly with regard to the comparison of percussion and pressure, one party maintaining a perfect congruity between these two forces, while others assert their total incomparability, observing, that the least quantity of percussion is greater than any pressure, however great; for, say they, the momentum of a body is measured by its mass into its velocity; if, therefore, the body A moves with a velocity $v$, while the body B is at rest, or has no velocity, the momentum of the former is $A \times v$, and of the latter $B \times 0$, and consequently the former is infinitely greater than the latter. But without following all the reasonings which are advanced on this subject, we will endeavour to trace the causes of the difference between the effects of impact and that of simple pressure. When a body, perfectly hard, and in motion, strikes another body also perfectly hard, the variation in motion ought to be preduced in an indivisible instant, and in such a manner, that between the initial velocity, and the velocity after the shock, there shall not be any intermediate velocity. But were the motion of the body modified by a pressure, or a constant force, as that of gravity, it would change by sensible degrees, and undergo a determinate variation at the end of a certain time. It is, therefore, the law of continuity which distinguishes the effects of compression from those of percussion, when the hardness is infinite; but as such hardness no where exists, matter always possessing a certain degree of elasticity, and limited cohesion of particles, which may be surmounted, we inquire, if percussion, considered physically, conforms to the law of continuity, when a body strikes another, two effects have place in each. First, the parts in contact yield to the action of the stroke, and become compressed, so that the figure of the bodies is altered by a flattening or impression, in the parts in contact, and in their neighbourhood. Secondly, when the flattening or impression has arrived at the greatest degree of which the bodies are susceptible, their inherent elasticity tends to detroy the impression, and effaces it wholly, or in part; this produces a mutual action and re-action, which is continued till the bodies are no longer in contact. Thus, as soon as bodies come into sensible contact, compression begins; as in the case of two balls, which will therefore touch only in one point. The mutual pressure which is necessary to produce the retardation of A, and the acceleration of B, is exerted only on the foremost particle of A, and the hindmost particle of B; but no atom of matter can be put in motion, or have its motion changed, unless it be acted on by an adequate force. And the force urging any individual particle, must be precisely competent to the production of the very change of motion which obtains in that particle. Except the two particles which come into contact in the collision, all the other particles are actuated by the forces which connect them; and the force acting on any one is generally compounded of many forces, which connect that particle with those adjoining. Therefore, when A overtakes B, the foremost particle of A is immediately retarded; the particles behind it would move forward, if their mutual connexion were dissolved in that instant; but this remaining, they only approach nearer to the foremost striking particles, and thus make a compression, which gives occasion for the inherent elasticity to exert itself, and by its re-action retard the following particles. Thus each stratum, (so to conceive it,) continuing in motion, makes a compression, which occasions the elasticity to re-act, and by re-acting, to retard the stratum immediately behind it. This happens in succession: the compression and elastic re-action begin in the anterior stratum, and take place in succession backward, and the whole body gets into a state of compression. All this is done in an instant, (as we commonly, but inaccurately, speak;) that is, in a very small and insensible moment of time; but in this moment there is the same gradual compression, increase of mutual action, greatest compression, common velocity, subsequent restitution, and final separation, as in the case of bodies with a slender spring interposed, or even in the case of mutual repelling magnets. In all the cases, the changes of motion are produced by the elasticity, or the repulsion, and not by the transfusion of the force of motion. The changing force is, indeed, inherent to the bodies, but not because they are in motion; the use of the motion is to give occasion, by continued compression, for the continued operation of the inherent elasticity. Hence it appears that the law of continuity has actually place in the impact of bodies, and that no alteration in their motion takes place without their previously partaking of all the intermediate alterations. This alteration is always produced during an extremely short interval of time, and this occasions the great disproportion observed between the effects of impact and those of pressure; but it is, notwithstanding, inconceivable "that any really existing body should pass from quiescence into finite motion, or from one degree of finite motion to another, without having possessed all the intermediate degrees of velocity;" and hence it follows, that the phenomena of collision may be considered of a kindred class to those which are occasioned by accelerating or retarding forces, and act by insensible degrees, in order to produce a finite effect.

Percussion *Powder*.—Take two parts of the chlorate of potash, and one of antimony; they must be separately levigated to an impalpable powder, in a marble mortar, and mixed together with an ivory knife: to granulate it, it must be made into a thick paste, with spirit of wine, in which must be dissolved a little gum-mastic, to make it adhesive; and by forcing it through a hair sieve, it will be formed into grains. Four parts of potash, and one of antimony, will detonate; but this mixture was found, after a great number of trials by an eminent chemist, not to be sufficiently strong to be depended upon. To use fulminating mercury is highly dangerous, as the most serious accidents might arise, from its detonating by the slightest friction; and so far from its application to this purpose being a new discovery, it has been used as a percussion powder some years ago.

Percussion *Lock, by Wightman, of Malton, Yorkshire.*—A, the lock plate; B, the cock; C, a screw, the point of which is made to fit the pan; D, the magazine, the chamber of which, that contains the priming powder, is shewn by dotted lines; E, a hole in the magazine, through which the roller F passes; G, a cup drilled to contain 1½ grains of powder; H, a small lever, fixed on a square on the end of the roller, and fastened by means of a screw; I, a cylinder, screwed into the breech of the gun, and through which a communication is made from the pan into the barrel; K, the pan, the size of which is the same as the cup in the roller. To prime this lock, it must first be put to half-cock; then place the magazines on the pan, as is shewn by the figure; and by turning the roller by means of the lever, half a circle, the priming is transmitted from the magazine into the pan, and the percussion of the screw C, on the priming, causes ignition. To enumerate the qualities of this lock would be unnecessary; for by a reference to the engraving, its very valuable properties will be sufficiently understood.—*Mech. Mag.*



**PERENNIAL**, in Botany, is applied to those plants whose roots will abide many years, whether they retain their leaves in winter or not: those which retain their leaves are called evergreens; but such as cast their leaves, are called deciduous.

**PERGALESIA**, a genus of the pentandria dyginia class and order, of which there are five species.

**PERIAGUA**, a sort of large canoe, composed of the trunks of two trees, hollowed and united in one fabric; whereas canoes in general are formed of only the body of one tree. The periagua is used in South America and the Gulf of Mexico.

**PERICARDIUM**, in Anatomy, is a membranous bag filled with water, which contains the heart in man, and many other animals. It is formed by a duplicate of the membrane which divides the thorax into two unequal parts.

**PERICARPIUM**, among Botanists, a covering or case for the seeds of plants.

**PERIGEE**, or **PERIGÆUM**, in the ancient Astronomy, signified the nearest approach of the sun, or any of the planets, to the earth; or rather, that point of their orbit when at their least distance; a term which the moderns have changed to *perihelion*, because it is the earth that is in motion, and not the sun, as was supposed by the ancients. The term perigee is, however, still properly used, as applied to the moon, comets, &c. to denote their nearest approach to our planet.

**PERIHELION**, or **PERIHELIUM**, that point in the orbit of a planet, or comet, which is nearest to the sun; being the extremity of their transverse axis, nearest to that focus in which the sun is placed; being thus opposed to the aphelion, which is the opposite extremity of the same axis. The perihelion distances of the several planets, the mean distance of the earth from the sun being taken as unity, are as follows:—

*Perihelion Distances of the Planets, the Mean Distance of the Earth being Unity.*

| | | | |
|---|---|---|---|
| Mercury, | ·1815831 | Ceres, | 2 6890660 |
| Venus, | ·7164793 | Pallas, | 2·5222080 |
| Earth, | ·9831468 | Jupiter, | 5·1546127 |
| Mars, | 1·4305595 | Saturn, | 9·4826022 |
| Vesta, | 2.2797800 | Uranus, | 19·1366347 |
| Juno, | 2·4122190 | | |

**PERILLA**, a genus of the class and order didynamia gymnospermia.

**PERIMETER**, is the ambit or outward boundary of any figure; being the sum of all the sides in right-lined figures, and means the same as circumference or periphery in circular ones.

**PERIOD**, in Astronomy, is the time in which a planet or satellite makes one entire revolution in its orbit, or returns again to the same point in the heavens. It is one of the celebrated laws of Kepler, discovered by observation, and confirmed by Newton in his "Principia," that the squares of the periodic times of revolution are to each other as the cubes of the distance of the respective planets from the sun. And the same law has also place with all the satellites revolving about the same primary.

**PERIOD**, in Chronology, denotes an epoch, or space of time, by which the years are reckoned. *See* EPOCHA.

**PERIOD**, in Grammar, denotes a small compass of discourse, containing a perfect sentence, and distinguished at the end by a point or full stop, thus (.); and its members or divisions marked by commas, colons, &c.

**PERIODICAL**, returning at stated periods.

**PERIOECI**, are those who live in the same latitude, but in opposite longitudes; when it is noon with the one, it is midnight with the other; they have the same length of days, and the same seasons of the year. The inhabitants of the poles can have no Periœci.

**PERIOECIANS**, in Geography, are those people which inhabit the same parallel of latitude.

**PERIPATETIC PHILOSOPHY**, the system of philosophy taught and established by Aristotle; the word is derived from the Greek verb, *I walk*, because they always disputed while walking in the Lyceum.

**PERIPHERY**, in Geometry, the cirumference of a circle, ellipsis, or any other regular curvilinear figure. *See* CIRCLE, &c.

**PERISCII**, are those people who inhabit the frigid zones, so called, because their shadows, during a revolution of the earth on its axis, are directed towards every point of the compass. In the frigid zones, the sun does not set during several revolutions of the earth on its axis.

**PERISTYLE**, in ancient Architecture, a building encompassed with a row of columns on the inside.

**PERJURY**, in Law, false swearing, which is punished by the pillory, and by transportation; and this perjury is supposed to be committed in some court of justice having power to administer an oath, or before some magistrate.

**PERLATE ACID.** This name was given by Bergmann to the acidulous phosphate of soda.

**PERLATED ACID**, biphosphurate of soda.

**PERMIT**, a license or warrant for persons to pass with or sell goods, having paid the duties of custom and excise.

**PERMUTATIONS**, the changes in the position of things; differing from combinations in this, that the latter has no reference to the order in which the quantities are combined; whereas in the former, this order is considered, and consequently the number of permutations always exceeds the number of combinations. Permutation also differs from what is simply termed changes, in this,—that by changes, is commonly meant only the different order in which a number of things may be arranged, taking all together; whereas permutation implies a combination of a number of things into different sects, and the changes which may then have place amongst them. In general, the number of permutations may be found by first finding the number of combinations, and then the number of permutations in each; and the product of these is the whole number of permutations. *See* COMBINATIONS.

**PERORATION**, in Rhetoric, the epilogue or last part of an oration, wherein what the orator had insisted on through his whole discourse is urged afresh with greater vehemence and passion.

**PEROXIDE**, in Chemistry, denotes the maximum of oxidizement. *See* OXIDE.

**PERPENDICULAR**, in Geometry, is formed by one line meeting another, so as to make the angles on each side of it equal to each other.

**PERPENDICULAR** to a *Curve*, is a line perpendicular to the tangent of the curve at that point.

**PERPENDICULAR** to a *Parabola*, is a right line cutting the parabola in the point in which any other right line touches it, and is also itself perpendicular to that tangent.

**PERPENDICULAR** *Action of Gravity*, is the direction which it gives to a body falling freely, which is always in a line perpendicular to a tangent to the earth's surface at that point, and not necessarily in a line directed to the centre of the earth.

*To erect a Perpendicular upon a given Point* C, *in a given Line* A B.—When the point is near the middle of the line, fig. 1. On each side of the point C take any two equal distances C *n*, C *m*. From *n* and *m*, with any radius greater than C *n* or C *m*, describe arcs cutting each other in *s*. Through the point *s* draw the line *s* C, and it will be the perpendicular required. When the point is at or near the end of the line, fig. 2. Take any point *o*, and with the radius or distance *o* C describe the arc *m* C *n*, cutting A B in *m* and C. Through the centre *o*, and the point *m*, draw the line *m o n*, cutting the arc *m* C *n* in *n*. From the point *n* draw the line *n* C, and it will be the perpendicular required.

*Fig.* 1.

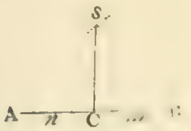
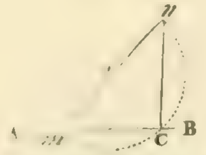


*Fig.* 2.



*From a given Point* C, *to let fall a Perpendicular upon a given Line* A B.—When the point is nearly opposite the middle of the given line, fig. 3. From the point C, with any radius, describe the arc *n m* cutting A B in *n* and *m*. From the points *n*, *m*, with the same, or any other radius, describe two arcs cutting each other in S. Through the points C S draw the line C G S, and C G will be the perpendicular required. When the point is nearly opposite to the end of the line, fig. 4. To any point *m*, in the line A B, draw the line C *m*. Bisect the line C *m*, or divide it into two equal parts, in the point *n*. From *n*, with the radius *n m* or *n* C, describe the arc C G *m*, cutting A B in G. Through the point C draw the line C G, and it will be the perpendicular required.

*Fig.* 3.

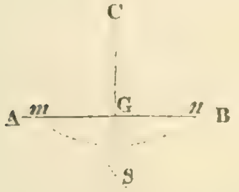
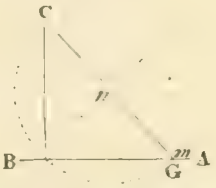
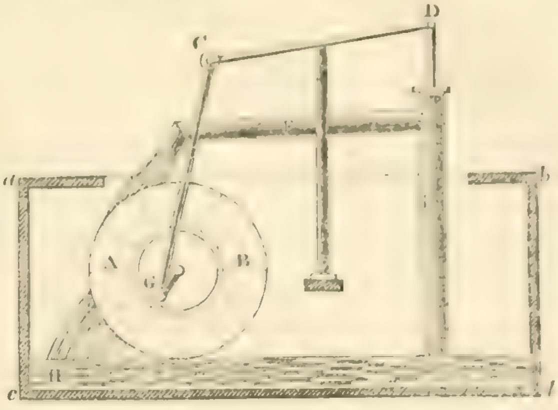


*Fig.* 4.



*Perpendiculars* are best described in practice by means of a square; one of whose legs is applied along that line, to or from which the perpendicular is to be let fall or raised.

PERPETUAL Motion, is that which possesses within itself the principle of motion; and consequently, since every body in nature, when in motion, would continue in that state, every motion, once begun, would be perpetual but for the operation of some external causes; such are those of friction, resistance, &c.; and since it is also a known principle in mechanics, that no absolute power can be gained by any combination of machinery, except there being at the same time an equal gain in an opposite direction; but that, on the contrary, there must necessarily be some lost from the above causes, it follows, that a perpetual motion can never take place from any pure mechanical combination; yet this is a problem which has engaged the attention of many ingenious men, from the earliest period to the present time, though it has but seldom been attempted by men of science, since the true laws of mechanics have been so well established. The annexed sketch exhibits an idea of a mechanical contrivance to work without intermission, till its parts are destroyed by friction. *a b c d* is the section of the reservoir, &c. shewing the wheel, the pump, &c. A B is an overshot water wheel; C D, the working beam; E, the pump; F, a pipe from the top of the pump, through which the water was to fall upon the wheel; C G, an arm, communicating, by means of a crank attached to an horizontal shaft through the centre of the wheel, motion to the lever, or working beam, and so raising water from the reservoir by means of the pump; H I, the water. It was supposed, that the water which had fallen upon the wheel into the reservoir, would be raised by means of the pump, fall through the horizontal pipe, and so produce a continued rotatory motion. Experiment has, however, proved its inutility. The machine cannot furnish water enough to perpetuate its motion.



PERPETUITY, is where, if all that have interest join in the conveyance, yet they cannot bar or pass the estates; for, if by concurrence of all having interest, the estate may be barred, it is no perpetuity. 1 Chan. Ca. 213.

Perpetuity, in the doctrine of Annuities, is the number of years in which the simple interest of any principal sum will amount to the same as the principal itself; or it is the quantity arising by dividing 100, or any other principal, by its interest for one year. Thus the perpetuity at the rate of 5 per cent, is $\frac{100}{5} = 20$ years; and at 4 per cent. $\frac{100}{4} = 25$ years.

PERSECUTION, is any unjust pain or affliction which a person designedly inflicts upon another; and, in a more restrained sense, the sufferings of Christians, or indeed of any others, on account of their religion.

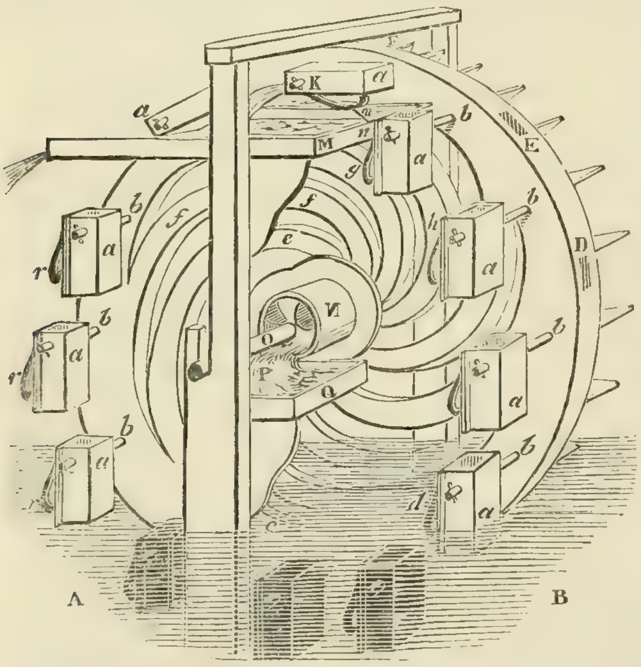
PERSEUS et CAPUT MEDUSÆ. *Perseus and the Head of Medusa*, one of the northern constellations, which, according to the fables of the Greeks, represents Perseus the son of Jupiter and husband of Andromeda, who signalized himself at the court of Cepheus, by rescuing this princess from a marine monster by means of Medusa's head. When the celestial luminaries which were created "for signs and seasons," became in their movements connected in the mind of mankind with the fate of individuals and the destinies of nations, the conjunction and opposition of the planets were made subjects of joy and lamentation; for blessings or misfortunes were supposed to follow the rising or setting of the unconscious constellations, and the science of the ancient Chaldeans and Egyptians, which was also their religion, introduced a mob of deified mortals, composed of heroes, tyrants, women, and boys. The fears of men were changed into reverence and love, their reverence into the worship of the host of heaven, when mythology seduced them from the religion of the Supreme Being. Cepheus, Perseus, and Hercules, were stationed in the starry heavens, where Cassiopeia and Andromeda have each a portion of the celestial sphere, where Orion leads on the most brilliant of the constellations, and where his eagle had borne the favourite of Jupiter, ages before a place was assigned to the minion of Adrian. Thus may we account for the Egyptian figments concerning the dynasties and the wars of the gods; for the marvels and the monsters which sprang from their allegorical mythology; for the hero worship of the Greeks, and all the clumsy inventions of a degraded superstition among the conquerors of the world. The Milky Way around Perseus is very vivid, being undoubtedly a rich stratum of fixed stars, presenting the most wonderful and sublime phenomenon of the Creator's power and greatness. Köhler, the astronomer, observed a beautiful nebula near the face of Perseus. But the most remarkable phenomenon in this constellation is the variable star *Algol*, which changes continually from the 2d to the 4th magnitude. This star has $11^h\ 56'\ 30''$ right ascension in time, and $40^\circ\ 15'\ 19''$ declination N. The time taken up from its greatest to its least lustre, is 2 days, 20 hours, and 49 minutes, or about 69 hours. During four hours of this period it gradually diminishes in brightness, which it recovers in the succeeding four hours; and in the remaining part of the time it invariably preserves its greatest lustre; and after the expiration of this term its decrease commences. Mons. Bode allows seven hours for Algol's reduction from the 2d to the 4th magnitude.

**PERSON**, in Grammar, a term applied to such nouns or pronouns, as, either prefixed or understood, are the nominatives in all inflections of a verb; or it is the agent or patient in all finite and personal verbs.

**PERSONATE**, is the representing a person by a fictitious or assumed character, so as to pass for the person represented.

**PERSONATÆ**, in Botany, the 40th order in the fragments of Linnæus' natural method, consisting of numerous plants, and whose genera arrange themselves under the class and order didynamia angiospermia of the sexual method.

**PERSIAN WHEEL**, is a name given to a machine for raising water, which may be turned by means of a stream A B acting upon the wheel C D E according to the order of the letters. The buckets *a*, *a*, *a*, *a*, &c. instead of being firmly fastened, are hung upon the wheel by strong pins, *b*, *b*, *b*, *b*, &c. fixed in the side of the rim; which must be made as high as the water is intended to be raised above the level of that part of the stream in which the wheel is placed. As the wheel turns, the buckets on the right hand go down into the water, where they are filled, and return up full on the left hand till they come to the top at K; where they strike against the end *n* of the fixed trough M, by which they are overset, and so empty the water into the trough; from whence it is to be conveyed in pipes to any place it is intended for; and as each bucket gets over the trough, it falls into a perpendicular position again, and so goes down empty till it comes to the water at A, where it is filled as before. On each bucket is a spring *r*, which going over the top or crown of the bar *n* (fixed to the trough M) raises the bottom of the bucket above the level of its mouth, and so causes it to empty all its water into the trough. Sometimes this wheel is made to raise water no higher than its axis; and then, instead of buckets hung upon it, its spokes C, *d*, *e*, *f*, *g*, *h*, are made of a bent form, and hollow within, these hollows opening into holes C, D, E, F, in the outside of the wheel, and also into O in the box N upon the axis. So that, as the holes C, D, &c. dip in the water, it runs into them; and as the wheel turns, the water rises in the hollow spokes *c*, *d*, &c. and runs out in a stream, P, from the holes at O, and falls into the trough Q, from whence it is conveyed by pipes. This is a very easy way to raise water, because the engine requires neither men nor horses to turn it. To determine the due relation of the power and the weight, so that this wheel may be capable of producing the greatest effect, the following may be taken as a good approximation. After having fixed the diameter of the wheel, which must be something greater than the altitude to which the water is to be raised; fix also upon an even number of buckets to be hung at equal distances round the periphery of the wheel, and mark the position of their centres of motion in such a manner that they will stand in corresponding positions in every quarter of the circle; conceive vertical lines drawn through the centre of motion of each bucket in the rising part of the wheel; they will intersect the horizontal diameter of the wheel in points at which, if the buckets were hung, they would furnish the same resistance to the moving force as they do when hanging at their respective places on the rim of the wheel. Thus, supposing there were 18 equidistant buckets; then while 8 hung on each side a vertical diameter of the wheel, there would be 8 on the other side, and 2 would coincide with that diameter; in this case the resistance arising from all the full buckets would be the same as if one bucket hung on the prolongation of the horizontal diameter at the distance of $2 \sin 20° + 2 \sin 40° + 2 \sin 60° + 2 \sin 80°$, these being the sines of the common radius of the wheel. To know the quantity of water that each bucket should contain, take $\frac{4}{9}$ of the absolute force of the stream, that is, $\frac{4}{9}$ of the weight of the prism of water whose base is the surface of one of the float-boards, and whose height is that through which water must fall to acquire the velocity of the stream; so have we the power that should be in equilibrio with the weight of water in the buckets of the rising semicircle. Then say, as the sum of the sines mentioned above is to radius, so is the power just found to a fourth term, the half of which will be the weight of water that ought to be contained in one bucket. Lastly, as the velocity of the wheel will be to that of the stream nearly as one to $2\frac{1}{3}$, the quantity of revolutions it makes in any determinate time becomes known, and, of consequence, the quantity of water the wheel will raise in the same time; since we know the capacity of each bucket, and the number of them emptied in every revolution of the wheel.



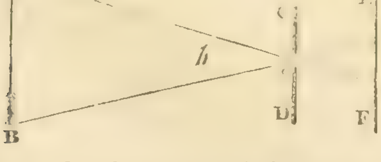
**PERSPECTIVE**, is the art of delineating objects on any given surface, as they would appear to the eye, if that surface were transparent, and the objects themselves were seen through it from a fixed situation.

To commence with what we hope will be found a very easy way of acquiring a general knowledge of the subject; let the student place himself in a darkened chamber, and there let him make a small hole, not larger than a pea, in the door or window, opposite to some remarkable objects, such as houses or trees, the distance of which should be at least equal to their height, and may with propriety be two or three times that distance; and the experiment will be most agreeably conducted, when the sun shines strongly on the surfaces facing the hole. If a sheet of paper, or any white screen, be placed within the room before the hole, an image of the external objects opposite the aperture will be depicted upon it. The image will be beautiful, although the outline of the objects will not be very well defined, nor their colours very distinct, for reasons which the study of optics will fully explain. The instruction, however, to be derived from the experiment, will for the present object be the same. It will be observed, that the images of all objects are inverted; and to understand this, the student must be reminded of the rectilinear motion of light. The image on the screen can of course be formed only by those rays of light which enter the chamber at the aperture, and it will be admitted that the rays from the top of the external objects cannot proceed in a right line to the screen, unless they proceed to the bottom of the screen; therefore, as each ray carries with it the image of the point from which it issued, the top of the objects must be at the bottom of the screen, and the objects on the left hand will be on the right of the image. That the rays of light from the objects cross each other at the aperture, and spread afterwards as they advance, may be proved by varying the distance of the screen; the size of the image upon which, is enlarged by drawing it back, and lessened by placing it nearer the aperture. The student must further be informed, that if he could trace the image on the screen exactly as it is there delineated, he would on reversing the screen, have an outline of the external objects in accurate perspective. As the proportions of the several parts, therefore, are not altered by the inverted position of the image, they may be contemplated and compared with the original objects, as if no inversion took place. Suppose the front of a single house to be parallel to the surface of the screen, and its centre very nearly opposite to the centre of the aperture, its image upon the screen will be of the same shape as the front itself is known to have, and its dimensions will be obtained by a rule easily discoverable, for the image will be very nearly as much less than the original, as the distance between the image and the aperture is less than the distance between the original and the aperture. This estimate of the proportion between the image and the object, would not require the qualifying term *nearly*, but would be correct, if the aperture were exactly opposite the centre of the front of the house: but we have supposed the aperture to be nearer one side of the building than the other, in order that the rays from the nearest gable of the house may pass through the aperture. This being attended to there, will be an image of the gable end upon the screen, and the size and shape of this part of the image must be particularly noticed. It will be found that though the gable may be in reality as broad as the front, its image is extremely narrow; that its ground line, instead of being level with that of the front, inclines more and more towards the top as it recedes from the eye, and that the further edge of the inclined roof inclines to this line with a greater degree of inclination than the original is known to have; thus besides the narrowness in point of breadth, the height of the most distant corner of the gable is in the image shorter than the hithermost corner. This visual contraction of surfaces is called fore-shortening.

To understand how it happens, let the student suppose a thread stretched from any given point in the most distant angle or vertical edge of the gable, to its image on the screen, or spot on which it would fall by taking a rectilinear course; let another line be supposed to be drawn from an opposite point of the nearest angle of the gable, and it will be perceived that as these lines, like the rays of light, cross the aperture, they will at the screen form but a very narrow opening; and as the breadth of the image cannot be greater than this opening, the breadth of the gable must be inconsiderable on the screen. It will be obvious at the same time, that the more nearly the gable is taken in front, the greater will be the breadth of its image, while that of the apparent extent of the front will be proportionably contracted. The inclination of the ground line of the gable will be explained, by supposing lines to be drawn from the four corners or limits of the gable to their respective places on the screen; for the line which bounds the further side of the gable, must have a less image on the screen than the hithermost, because it is more distant, and at an intermediate distance, any vertical line in the gable must have an intermediate height: therefore there must be in the picture a gradual rising of the ground line towards a point horizontally opposite the place of the aperture:—Now the whole art of perspective consists in observing rules which teach us to discover the diminutions of all objects seen obliquely like the gable end of the house. To render this experiment, and the inferences drawn from it, perfectly clear, it ought to be tried and fully considered. It will then speak to the eye, and the object to be obtained by perspective can scarcely be misunderstood, whereas the impression of mere words is speedily effaced.

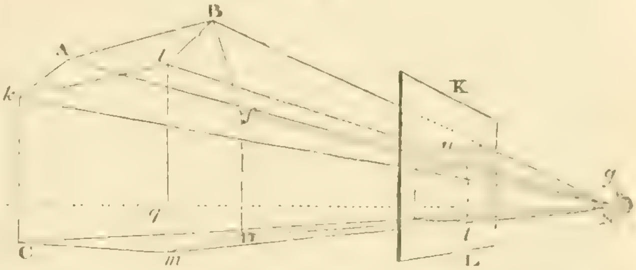
To prevent any incorrect inference, we shall however refer to fig. 1, where, let C D represent the window shutter of the darkened chamber, and *g* the aperture in it; A B an external object, and E F the screen which receives its image. It must be observed, that the darkened chamber is used only as a means of separating the rays which form an image from any other; and that if the direction of the rays could be ascertained as much before the shutter, as they are here behind it, an image of the original object would be obtained of the same size as that upon the screen, and in its erect position, because the rays have not crossed. Accordingly in the practice of perspective, the rays of light from an object are always supposed to be intercepted as they converge to the eye at some point, as at *h*, between the original object and the eye. In the experiment, therefore, the aperture in the window-shutter must be considered as representing the pupil of the eye, the darkened chamber the chamber of the eye, and the screen the retina, or as a means of rendering visible the pictures which the eye receives of visible objects. We need not observe, that a larger aperture, with a convex glass set in it, would in fact form a camera obscura, and a very distinct image would be painted on the screen, at the focus of the glass; but the experiment would then be less simple, and the direction of the rays not so evident. Without a glass, the distinctness of the picture is sufficient to be agreeable, when the eye has been some time in the chamber.

*Fig.* 1.



To consider the foundation of perspective in another point of view, let A B C D, fig. 2, represent a house, seen by the eye at N. The eye N is supposed to be opposite the corner *q* of the house; its distance from which is equal to N *q*, and its height five feet from the ground. The situation of the eye corresponds to that of the hole in the window-shutter of the former experiment, and the picture of the house formed in the eye itself, corresponds to that which the screen received. In this situation, as in every other, straight lines drawn from every part of the house to the eye, represent the direction of the rays which form the images of those parts respectively, and thereby render the house visible. The eye, it must be understood, is considered as fixed upon the point *q*, directly before it, and in order that no sensible deviation may be possible, we may suppose it to be looking through a very small aperture in a piece of thin brass *g*. If now a transparent plane, for example a pane of glass. K L, be interposed between the house and the eye, at a short distance from the eye, the whole of the house will be seen through the transparent plane, although the latter is comparatively with the house of very small dimensions, because the rays, in proceeding to their point of convergence at the eye, have approached each other in a proportion inversely as the distance; that is, at half the distance from the object, they only extend over half the space contained between the points of emission; at one-fourth of the distance from the eye, they only take up one-fourth of the space; and the same proportion holds for other distances. Suppose the pane of glass to be within arm's reach of the eye at N, and that it is coated with gum-water or isinglass so as to receive the marks of a pencil, without having its transparency destroyed; trace the outlines of the house upon the glass, by observing and following exactly the direction in which they are seen through the small aperture in the piece of brass. When this is done, it will be found that the real or measured extents forming the different external surfaces of the house, are represented by extents modified by the distance and obliquity of these surfaces to the eye —in short, as shewn in the figure, a representation of the house in true perspective will be obtained, in the given situation of the eye. To young persons the difficulty of understanding an explanation of this kind is occasioned by their indistinct perception of the relation between the rays and lines from a real

*Fig.* 2.



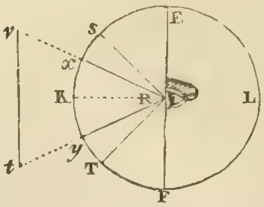
object, and the projection of those lines upon a flat surface, as a sheet of paper. It appears confusing to them to say that the eye is opposite to the corner *q* of the house, and yet to represent it at N on one side. Unless this difficulty be overcome, and the mind can form a distinct image of the direction which the line shewn on paper would have if drawn from a real object, perspective diagrams will be contemplated with pain, and the remembrance of them will soon be effaced. We shall therefore propose a little experiment, which we recommend to be tried by those who feel the difficulty alluded to.

Let a small model of a house be made of wood, and to every corner of it which can be seen in any one situation, affix a thread of silk, two or three times as long as the model of the house is high. These threads will represent the rays of light proceeding from the corners A B C D, *f k l m*, of the house, in fig. 2. Let the threads be drawn through a hole in a piece of thin brass, just large enough to admit them to be moved freely. The hole in the piece of brass will represent the eye. Let small weights be attached to the extremities of the threads which have been passed through the hole in the brass: the threads being thus stretched, will form a right line from the house to the brass, and the apparatus will be ready for elucidating the nature of perspective. While the model of the house remains stationary, let the position of the brass be varied, sometimes placing it higher, sometimes lower, at different distances and towards different sides; and let the angles formed by the threads in each situation be attentively considered, by the observer placing himself behind the brass, and supposing himself to regard the house as if he saw it through the hole. Let him, after each remove of the brass, suppose that the threads representing the rays of light, without altering their direction, were to pass through a sheet of paper, interposed at any distance between the brass and the house, and he would find that by drawing lines to join the points thus obtained, an outline representation of the house would be produced, and this representation would be in true perspective. For any one situation it would not be a troublesome matter to perforate a piece of paper, to be slipped upon the threads without distorting them; and for other situations, a good idea of what the representation would be, or, in other words, of the perspective space between any given points, would be obtained by measuring the openings between the threads at equal distances from the brass. After the trial and proper consideration of this experiment, it will be easy to form a tolerably correct idea of the perspective appearance of any object, or assemblage of objects, and not difficult to exhibit that appearance on paper. In perspective diagrams, lines must be drawn to represent the rays, the direction of which in this experiment is indicated by threads, and as the view of an object varies with the point from which it is seen, the situation of the eye, both in height and distance, must be laid down upon the paper on which the perspective drawing of an object is to be made, unless we propose to look at the object itself as through a transparent plane. The question then occurs, how shall the position of the eye be designated on paper?—It can no way be represented so clearly as by placing it on one side, as shewn in the figure, or by placing it vertically beneath the object to be drawn, as represented in fig. 12.

By whatever means the representation *t u*, fig. 2, of an object A B C D, is obtained, if the outline be accurate, and viewed at a proper distance, it is plain it will make an outline of the same form in the eye as the object itself: and if the colouring were equally perfect, the eye might mistake the figure for the original. But even when colours are not employed, correct dimensions give the whole a pleasing appearance, and constitute the first great requisite to every good picture.

Having thus endeavoured to explain the nature of perspective, we may next advert to the limits of vision. We may consider the eye, in whatever direction we look, as situated in the centre of a sphere, which we may suppose to be represented by the circle E K F I, fig. 3. The hemisphere E L F is behind the eye, and therefore obviously invisible; and it is also certain, that the eye, looking forward horizontally to K, cannot take in at once the whole of the hemisphere E K F. So far from this, it cannot take in a larger angle than S R T, which is but half a hemisphere, or equal to 90 degrees. And as the rays which the eye takes in, extend all around to an equal distance from the central ray K R, it follows, that the whole of the rays which enter the eye at once, will be in the form of a cone, of which the apex is at the eye; and of such a cone of rays, S R T may be considered as the profile. It is, however, found, that to have an agreeable view of large objects, such as buildings, the angle of vision should not exceed 60 degrees, or one-third of a hemisphere; in other words, that we cannot distinctly see the whole of any object, unless its distance from the eye be at least equal to its height; and the appearance of a picture will be more agreeable, if not made to comprehend above 45, or at most 50 degrees; indeed, for small objects, or such as do not exceed the length of a foot in any of their dimensions, it is not advisable to exceed an angle of 30 degrees. As a picture, therefore, should never comprise more than the eye can easily take in at one view, a distance of 25 degrees on either side of the point of sight, may be considered a standard limit. Fifty degrees, to the eye at B, are comprehended in the angle *x* R *y*; and we need scarcely observe, that the measure of an angle, is the space it takes up on the circumference of a circle, which has the point of the angle for its centre; a circle being always supposed to contain 360 degrees. Hence, if the lines forming the angle *x* R *y*, were extended, the angle *v* R *t* would still be only one of fifty degrees, because, whatever were the size of a circle drawn from the point R, through its two legs, if that circle were divided into 360 parts, the number of those parts enclosed by the angle could not be more than fifty.

*Fig.* 3.



We shall now proceed to the definitions of the terms used in treating of perspective, and then shew the method of putting into perspective, those forms which may be considered as the elements of all others.

*Definitions.*—1. An *original object*, is any object whatever, which is rendered the subject of a picture.

2. *Original planes* or *lines*, are the surfaces or lines of original objects.

3. *Perspective plane*, is the surface on which a picture is delineated.—It may here be observed, that painters regard the frame of a picture merely as an aperture through which original objects are seen; and they therefore consider the perspective plane to be transparent, to admit of this view. It is on this account that the perspective plane is frequently called the *transparent* plane.

4. *Ground plane*, is the earth or surface on which stand the objects to be delineated, as well as the spectator.

5. *Ground line*, is the line on which the perspective plane is supposed to rest.

6. *Visual rays*, are those which, passing through the transparent plane, render original objects visible.

7. *Principal visual ray*, is that which passes through the axis or centre of the eye, and the course of which, therefore, from the perspective plane is shorter than any other, because it is perfectly direct. Its height above the ground line is of course always the same as that of the eye.

8. *Point of sight*, is that fixed point from which the spectator looks upon the perspective plane, when any original object is delineated.

9. *Centre of the picture*, is that point of the perspective plane which is exactly opposite the point of sight, that is, where the principal visual ray enters the transparent or perspective plane. It must, therefore, be carefully distinguished from the measured centre of any picture, as it can never exceed the height of the eye from the ground line.

10. *The distance of the picture*, or *point of distance*, is the distance between the eye or point of sight, and the centre of the picture.

11. *Vanishing points*, are those points to which all lines inclined to the picture appear to converge, and in which those lines meet when produced. Vanishing points have no place in a finished picture; they are used to facilitate drawing in perspective.

12. *The horizontal line*, is a line parallel with the horizon, at

the height of the eye, that is, it passes horizontally through the centre of the picture.

13. *Distance of a vanishing point*, is the distance from the vanishing point on the picture to the eye of the spectator.

It may also be proper to remind some, of the difference between a perpendicular and a vertical line or plane: a vertical line points directly to the centre of the earth; it is therefore at right angles to the plane of the horizon, and is the same with the direction of a plumb line: a perpendicular line is any line which is at right angles to another; it may therefore sometimes be a vertical line, sometimes a horizontal one, or in any other position according to the direction of the line or surface with which it forms a right angle.

*Methods of putting Squares into Perspective.*—Suppose a square to be traced upon the ground at some distance before us; that we find upon admeasurement, the length of each side to be eight feet, and that we are opposite the centre of the nearest side, at the distance of eighteen feet. We know, that if we wish to obtain what is called a ground plan of this square, we must represent it by a square upon paper, as in fig. 4, and thus we shall have its real appearance, supposing the eye to be looking down upon it, just over its centre. But looking upon it obliquely as we have stated, and with the eye at the height of six feet from the ground, we are convinced, from the nature of perspective as before explained, that the side nearest to us will make a longer line upon the retina than any of the rest; the question is, therefore, to obtain the true appearance of the whole square, that is, the true form of the image it makes on the retina. In the first place, determine the scale to be observed, that is, what space shall correspond to a foot of the original; for example, suppose one-tenth of an inch. Then draw a line A B, fig. 5, eight-tenths of an inch long, and another line H D parallel with this base line, at the height of six-tenths of an inch from it. Raise a perpendicular from the centre of the line A B, and the point C, in which it cuts the horizontal line, will be the centre of the picture. From C, on the horizontal line, set off the distance at which the square is seen, which will here be eighteen-tenths of an inch, and the point of distance D, will be obtained. From A, draw the line A C; and from B, the line B C; then from A, draw the line A D, and to the point *h*, in which A D intersects B C, draw a line *g h*, parallel with the ground line A B; then will A *g* B *h*, form the perspective outline of the square required.

*Fig.* 4.

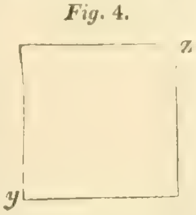
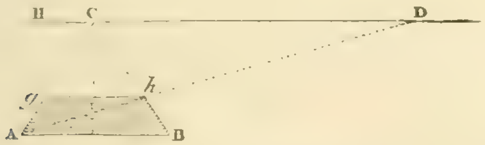
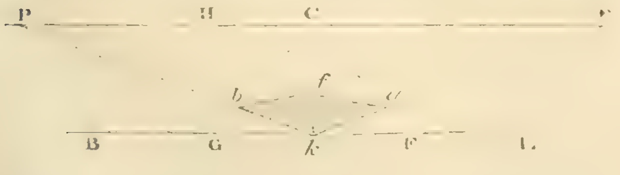


*Fig.* 5.



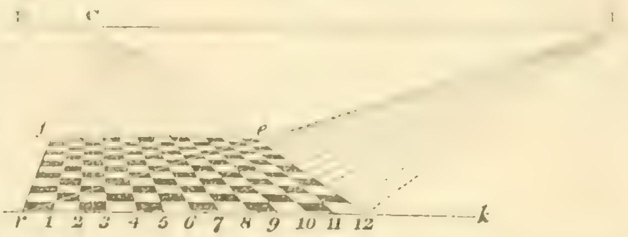
Let it be supposed, that the square above described is viewed by an eye situated opposite one of its corners, as in fig. 6. Draw a base line B L, as before, and on each side of any assumed point *k*, set off half the measured length of the diagonal of the square, *viz.* half the distance between the corners *y*, Z, fig. 4. Parallel to the base line, at the height of six-tenths of an inch from it, draw the horizontal line P H D, and raise from *k*, the perpendicular *k* C. From F draw the line F C, and from G, the line G C. On each side of the centre C, set off on the horizontal line the points of distance P D, and from each side of them draw lines to the centre of the base *k*; then from *a*, draw the line *a* P, and from *b*, the line *b* D, and the diagonal view *a b f k*, of the square, will be completed.

*Fig.* 6.



We shall give one more example respecting squares: suppose we have a square pavement, composed of equal alternate pieces of black and white marble; the total number of small pieces to be 144, and each of them one foot square, as

*Fig.* 7.



Here there will be six black and six white pieces on each side of the square. Suppose the spectator to stand opposite the middle of the third square on the left, and that for greater clearness, the scale be two-tenths of an inch to a foot, with the eye five feet above the ground, but at the distance of eighteen feet as before. Draw a base line *r k*, and divide a part of it into as many equal divisions as there are squares on one side of the original, as, 1, 2, 3, 4, &c. These divisions, by the scale now adopted, will each be two-tenths of an inch. Draw the horizontal line at the distance of five feet (according to the scale) from the base. From the middle of the space between 2 and 3, raise a perpendicular, and to the point C, in which it cuts the horizontal line, draw lines from the commencement and the termination of the divisions on the ground line, *viz.* *r* C and 12 C. From C, set off the distance C D, eighteen feet, for the distance of the eye. Draw the line *r* D, and from *e*, where it intersects the line 12 C, draw a line *ef*, parallel with the base line *r k*; then will *r f e* 12, give the boundaries of the pavement. To obtain the reticulations, draw lines from each of the divisions, 1, 2, 3, &c. on the base line, to the centre of the picture C, and from each of the same divisions to the point of the distance D. The lines drawn from the divisions to C, form the right and left sides of the small squares, and the lines drawn from the divisions to D, give the points on the line C 12, from which the horizontal lines may be drawn to form the other sides of the squares. Or, after all the lines are drawn from the divisions on the ground line to the centre C, and also the line *r D*, the remaining sides of the squares may be obtained by drawing parallel lines through the various points in which the part *r e*, of the line *r* D, intersects the lines drawn to the centre C.

It is often thought by those who are commencing this study, that representations such as the one now given have no resemblance to the originals; but if they be examined as every picture ought to be examined, opposite to the point of sight and at the distance for which they are drawn, the idea of their incorrectness will disappear; to render the illusion the more complete, the figure should be viewed through a small tube or aperture, to prevent the intrusion of surrounding objects. It must also be observed, that diagrams upon paper have frequently, for the sake of convenience, a vanishing point so near, that the eye has not the power of distinct vision at the distance for which they are drawn. Such designs, therefore, although correct in principle, will not appear correct to the eye unless enlarged.

*To put a Circle into Perspective.*—The perspective, or oblique view of a circle, is an ellipse, and it is usually obtained by drawing a square of a size just sufficient to contain the circle, and dividing it into small squares, then putting the divided square into the perspective, and drawing within it a line through the corresponding parts of the small squares, and this line will be an ellipse. Thus, to obtain the perspective of a circle E F G H, fig. 8, draw round it the square A B C D. Divide the square into small squares, the number of which should be increased in proportion to the exactness with which the perspective curve must be obtained; draw also the diagonals, C B and A D. Throw the square and reticulations into perspective, as represented in fig. 9, where C is the centre of the picture, and D the point of distance; then draw the curve by hand through the parts corresponding to those through which the circle passes in fig. 8. The perspective view of a circle will be an ellipse, whether the square is viewed opposite the middle of one of its sides, as in fig. 9; or even with one of its angles, as in fig. 10, where B C is the line of sight; or at a distance on one side, as in fig. 11, where L C is the line of sight. The point of distance, in figs. 10 and 11, is the same as in fig. 9, though in fig. 11 it could not be drawn without extending beyond the limits of the plate.

*Fig.* 8.

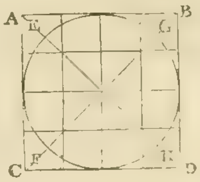


*Fig.* 9.

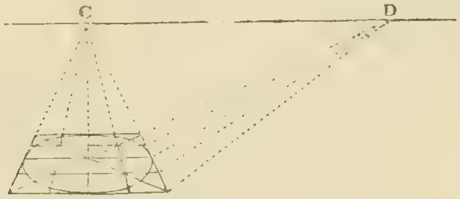


*Fig.* 10.

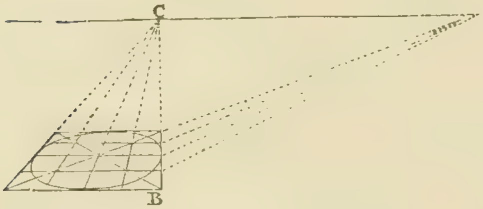
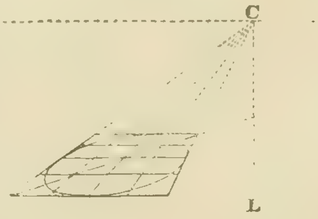


*Fig.* 11.



*To put a Triangular Prism into Perspective.*—To represent in perspective a triangular prism or solid, standing vertically upon one of its ends, and viewed by an eye just opposite one of its angles; draw by admeasurement a plan of the prism, as *a b c*, fig. 12; then draw the line G K across the outermost boundary of the triangle, and make E F parallel with G K. From *e* let fall the line *e d*, perpendicular to G K. On *c d* set off the measured distance of the eye from the prism, and mark the place of the eye as at *d*. From *a* and *b*, draw lines meeting each other in *d*. From *d*, draw the line *d m*, parallel with *a c* of the triangle, and on the other side the line *d l*, parallel with *b c*. From *e* raise the perpendicular *e f* to the measured height of the nearest angle of the prism to which the eye is opposite. On *e f*, measure the height of the eye from the ground line G K, and draw the horizontal line H H. Take the distance *c m*, set it off on each side from *n*, and it will give the vanishing points V P and V. Draw the lines *e* V P and *e* V. Then from *o* and *p*, where the lines from *a* and *b*, in proceeding to the eye, cut the line E F, draw the lines *p q* and *o s*, parallel with *e f*. Draw the lines V *x f*, and *f w* V P, and the perspective outlines *w f x r e z*, of the prism, whose base is equal to the triangle *a b c*, will be obtained, and may be finished by shading it according to the direction in which the light falls upon it. This mode of drawing from a ground plan is extremely useful, and well calculated to shew the difference between the visual and real dimensions of objects. The outlines of the house A B C D, in fig. 2, were obtained by it: it should be rendered familiar by frequent practice on figures in different positions.

*To put a Cube and a Cylinder into Perspective.*—As the base of a cube is a square, it may, when viewed as in the present example, opposite one of its angles, be put into perspective by the same process as the square in fig. 13, and figs. 9, 10, and 11, will explain the manner in which the perspective of a square, seen in other positions, may be obtained. Having then obtained the base, we shall find that when H is the horizontal line, P D the points of distance, and *a b* half the measured length of the diagonal of the cube, the perspective of the base will be represented by *a f d g*. Make the height of *a e* equal to the measur'd length according to the scale, of one of the sides of the cube, then draw the lines *e* D and *e* P. From *f* and *g*, draw lines parallel with *a e*, for the sides of the figure: draw the line *e* F to a perpendicular let fall from the horizontal line at P to M.

*Fig.* 12.

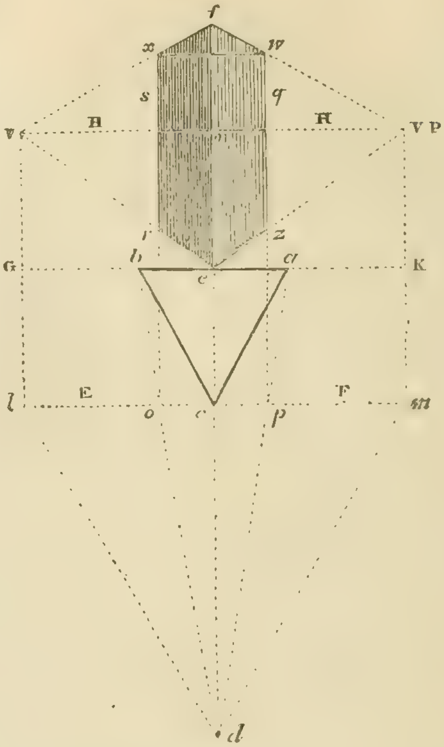
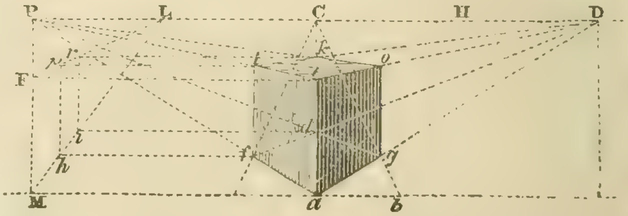
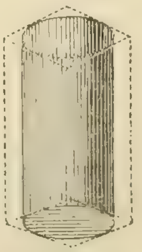


*Fig.* 13.



From F draw a line to any part of the horizontal line, as to L, and draw from M a line to meet this in L. To *f* draw the line *f h*, and to *d* the line *i d*; then from *h* and *i* raise perpendiculars to intersect F L, and from the points of intersection draw the lines *p l* and *r k*; thus will be obtained the perspective outline of the cube *k l f a g o e*. If the cube had not been viewed directly opposite one of its angles, the points of distance would not on each side have coincided with the vanishing points; and the vanishing points would have been best obtained as for the triangular prism, fig. 12.

*Fig.* 14.



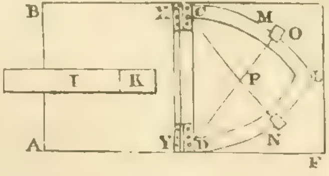
The procedure for a parallelopiped, is essentially the same as for a cube. To put a cylinder into perspective, first proceed as for a cube, or parallelopiped; draw on the perspective of each end such an ellipse as it will admit; let the longer or conjugate axes be equal, and join the opposite extremities of these axes by two parallel lines, as shewn in fig. 14. Having thus obtained the perspective of the cylinder, it only remains to erase the lines which belong to the cube or parallelopiped.

*Of Shadows, and Description of a Machine for Drawing in Perspective.*—Having now shewn the mode of putting into perspective those elementary forms which enter into the composition of drawings of every description, we shall be obliged to be concise with the remainder of the subject. The student must be aware how much difference of position affects the visual appearance of objects, and that by a proper attention to this circumstance, the few rules which have been given may be applied to subjects of considerable complication. To acquire a knowledge of the principles of perspective, it is recommended not merely to compare the plates with the printed page; but to copy the diagrams, and, for the sake of greater perspicuity, to do this on as large a scale as may be convenient. Afterwards some treatise especially devoted to the subject may be perused, and perhaps Brook Taylor's and Malton's may be the best; though these authors will require considerable attention, they have the merit of being sure guides.

With respect to shadows, the proper distribution of which give such life to perspective drawings, it may be useful to remark, that the shadow cast by any object covers the precise space which that object would prevent the eye from seeing, if the eye were in the place of the luminous body. The position, therefore, of the luminous body, must always be ascertained, and the shadow to be assigned to any object in a picture, will be a perspective view of the space which the eye would be prevented from seeing if in the place of the luminous body. A few experiments with a candle at night will be an easy mode of gaining a little acquaintance with this subject; it must, however, be observed, that the shadow from a candle is every way larger than that part of the object which intercepts the rays; but in point of breadth, this never happens with the shadows of the sun. The reason is, that the rays from the candle considerably diverge, while those from the sun, on account of the immense distance of that luminary, have no perceptible deviation from parallelism. It must be remembered also, that strong reflections from surrounding objects will diminish the intensity of shades, and that not only the quantity of light which falls on an object, but the quantity which can be reflected to the eye, must be considered.

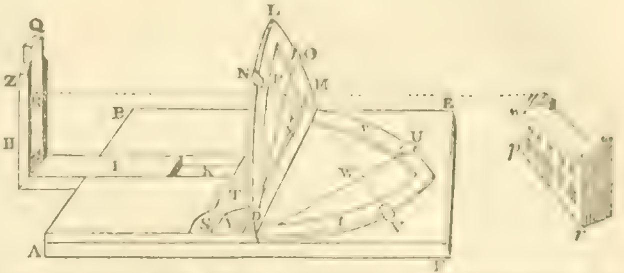
As it frequently happens that persons have occasion to draw in perspective, who have acquired no theoretical knowledge of the art; for the use of such, a great variety of machines have been constructed. Most of these machines are on optical principles; the camera obscura, which we have already described, is one of them, and the camera lucida is another. In praise of the latter, much has lately been said; but although it must be admitted to be a very portable and beautiful instrument, the acquisition of the proper art of using it, is extremely difficult to all, and to some impossible. Its chief use will be that of affording the means of contemplating the real perspective appearance of objects, and perhaps to obtain the position of a few points, but for very minute delineation it is of little value. For general use, we may venture to recommend an instrument described by Ferguson, to whom the knowledge of it was communicated by Dr. Bevis. It has the advantage of other machines in two points; it may be constructed at a small expense by any tolerably skilful artisan in wood, and the use of it will constantly tend to render the practice of perspective drawing more easy, by the manner in which it produces the measure of surfaces or angles. It will, therefore, better than most other other instruments for the same purpose, supply the want of a more extended essay.

*Fig.* 15.



The machine in question is represented at figs. 15 and 16. Fig. 15 is a plan, and fig. 16 a view of it on a larger scale. The same letters refer to the corresponding parts in both figures. A B E F is an oblong board, and X Y are two hinges, on which the part C L D is moveable. This part consists of two arches, or portions of arches, C M L, and D N L, joined together at the top L, and at the bottom to the cross bar D C, to which one part of each hinge is fixed, and the other part to a flat board, half the length of the board A B E F, and glued to its uppermost side. The centre of the arch C M L is at D, and the centre of the arch D N L is at C.

*Fig.* 16.



On the outer side of the arch D N L is a sliding piece, N, (much like the nut of the quadrant of altitude belonging to a common globe,) which may be moved to any part of the arch between D and L; and there is such another slider O, on the arch C M L, which may be set to any part between C and L. A thread C P N is stretched tight from the centre C to the slider N, and such another thread is stretched from the centre D to the slider O; the ends of the threads being fastened to these centres and sliders. It is plain, therefore, that by moving the sliders on their respective arches, the intersection P of the threads may be brought to any point of the open space within those arches.

In the groove K is a straight sliding bar I, which may be drawn further out, or pushed further in, at pleasure. To the outer end of this bar, I, fig. 16, is fixed the upright piece H Z, in which is a groove for receiving the sliding piece Q. In this slider is a small hole R, for the eye to look through in using the machine; and there is a long slit in H Z, to let the hole R be seen through when the eye is placed behind it, at any height of the hole above the level of the bar I.

Suppose a house, *q s r p*, to be at a considerable distance beyond the limits of the plate, to obtain a perspective representation of it, place the machine on a table, with the end E F, of the horizontal board A B E F towards the house, so that, when the arch D L C is set upright, the middle part of the open space (about P) within it, may be even with the house when the eye is placed at Z, and looking at the house through the small hole R; and then fix the corners of a square piece of paper with four wafers, on the surface of that half of the horizontal board which is nearest the house.

To complete the arrangement of the apparatus for drawing, set the arch upright as in the figure, which it will be when it comes to the perpendicular side T, of the upright piece S T, fixed to the horizontal board behind D. Then placing the eye at Z, look through the hole R at any point of the house, as *q*, and move the sliders N and O, till the intersection of the threads at P, is directly between the eye and the point *q*; then put down the arch flat upon the paper on the board, as at *s t*, and the intersection of the threads will be at W. Mark the point W on the paper with the dot of a black-lead pencil, and set the arch upright again as before; then look through the hole R, and move the sliders N and O, till the intersection of the threads comes between the eye and any other point of the house, as *w*; this being done, put down the arch again to the paper, and make a pencil mark thereon at the intersection of the thread as before; obtain the point *p* in the same manner, and draw a line from that mark to the one at *w*. The line *p w*, thus obtained, will be a representation in true perspective, of the corner *p q* of the house.

By thus bringing the intersection of the threads successively between the eye and other points of the outlines of the house, as *r s*, &c. and putting down the arch to mark the corresponding points, on the paper, at the intersection of the threads, then connecting these points by straight lines, the entire perspective outline of the house will be obtained. In like manner find points for the corners of the doors, windows, &c, and draw the finishing lines from point to point. The perspective drawing thus produced, may then be completed, by shading it according to the manner in which the light is observed to fall on the original.

Great care must be taken, during the whole of the time, that the position of the machine be not shifted on the table; and to prevent such an accident, the table or support employed should be perfectly steady, and the machine fixed down upon it by screws or clamps.

It is obvious that a landscape, or any number of objects within the field of view through the arch, may be delineated, by finding a sufficient number of points, and connecting them by straight or curved lines, as they appear in the original objects.

The arch ought to be not less than a foot wide at the bottom, that the eye at Z may have a large field of view through it; and the eye should be then at least ten inches and a half from the intersection of the threads at P, when the arch is set upright. If the eye be nearer, the boundaries of the view, at the sides near the foot of the arch, will subtend an angle at Z of more than 60 degrees, which will not only strain the eye, but will cause the outermost parts of the drawing to have a disagreeable appearance.—To avoid this, it will be proper to draw back the sliding bar I, till Z be fourteen inches and a half distant from P; then the whole field of view through the foot-wide arch, will not subtend an angle to the eye at Z of more than 45 degrees: which will give a more easy and pleasant view not only of the objects themselves, but of their representations upon the paper on which they are delineated. Hence, whatever may be the width of the arch, the distance of the eye from it should be in this proportion: as 12 is the width of the arch, so is 14½ to the distance of the eye (at Z) from it.

If a pane of glass, previously coated with thin gum-water, and dried, be fixed in the arch, a person who looks through the hole at R, may delineate upon the glass the objects which he sees at a distance, and the delineation may be afterwards transferred to paper. By this means will be saved the trouble of putting down the arch to take the position of every point, but it will not be so easy to obtain a correct representation.

PERSPECTIVE *Glass*, in Optics, differs from a telescope in this: instead of the convex eye-glass placed behind the image, to make the rays of each pencil go parallel to the eye, there is placed a concave eye-glass as much before it; which opens the converging rays, and makes them emerge parallel to the eye. The quantity of objects taken in at one view with this instrument does not depend upon the breadth of the eye-glass, as in the astronomical telescope, but upon the breadth of the pupil of the eye. Reflecting perspective glasses, called by some opera-glasses, or diagonal perspectives, are so contrived that a person can view any one in a public place, as the opera or play-houses, without it being possible to distinguish who it is he looks at. *See* OPERA GLASS.

PERSPECTIVE *Plane*, is the glass or other transparent surface, supposed to be placed between the eye and the object, perpendicular to the horizon. It is sometimes called the section table, or glass.

**PERSPIRATION**, in Physiology, the excretion of a fluid through the pores of the skin, and which is usually distinguished into sensible and insensible, or perceptible and imperceptible.

**PERU**, BALSAM OF. This substance is obtained from the myroxylum peruiferum, which grows in the warm parts of South America. The tree is full of resin, and the balsam is obtained by boiling the twigs in water. It has the consistency of honey, a brown colour, an agreeable smell, and a hot acrid taste.

**PERUKE.** It appears that this term was originally applied to describe a fine natural head of long hair; but whatever has been the ancient use or meaning of the word, it has now almost become obsolete, though it was for more than a century in constant application to those artificial heads of hair, made probably at first to conceal natural or accidental baldness, but which afterwards became so ridiculously fashionable, as to be worn in preference to the most beautiful locks, absurdly shaved off the head to make room for them.

**PERUVIAN BARK.** *See* CINCHONA. The penetrative effects of Peruvian bark are thus described by M. Delpech, a French merchant of Guayra, in the Caraccas, who in 1817 had stored up large quantities of fresh cinchona, in apartments which were afterwards required for the reception of some travellers as guests. These apartments contained each eight or ten thousand pounds of bark, and in consequence of its fermentation, the heat was much greater here than in the other parts of the house, rendering the place somewhat disagreeable. One of the beds placed in these rooms, was occupied by a traveller, ill of a malignant fever: after the first day he found himself much better, though he had taken no medicine; and in a few days he felt himself quite recovered, without any medical treatment whatsoever. This unexpected success induced M. Delpech to make some other trials: several persons ill of fever were placed successively in his magazine of cinchona, and they were all speedily cured, simply by the effluvia of the bark. It happened that a bale of coffee and some common French brandy were kept in the same place for some months; one of the brandy bottles happened to be uncorked, and on examination it was found to possess a slight aromatic taste, to be more tonic, and very superior to common brandy. The coffee also was much altered; when roasted it was more bitter than common coffee, and left in the mouth a taste similar to that of an infusion of bark.

**PETAL**, among Botanists, an appellation given to the flower leaves, in opposition to the folia, or common leaves of the plant.

**PETARD**, in the art of War, a metallic engine, somewhat resembling a high-crowned hat. Its use is in a clandestine attack to break down gates, bridges, barriers, &c. to which it is hung; and this it does by means of the wooden plank attached to it. It is also used in countermines, to break through the enemy's galleries, and give their mines vent.

**PETERERO**, or PATTERERO, a small piece of ordnance used on board ships for the discharging of nails, broken iron, or partridge shot, on an enemy attempting to board. They are generally open at the breech, and their chamber made to take out to be loaded that way instead of at the muzzle

**PETER-PENCE.** An ancient tax of a penny on each house, paid to the pope.

**PETEVERIA**, a genus of plants belonging to the hexandria class, and in the natural method ranking under the 14th order, Holoraceæ.

**PETITIO PRINCIPII**, in Logic, the taking a thing for true, and drawing conclusions from it as such, when it is really false, or at least wants to be proved before any inferences can be deduced from it.

**PETITION.** No petition to the king, or to either house of parliament, for any alteration in church or state, shall be signed by above twenty persons, unless the matter thereof is approved by three justices of the peace, or the major part of the grand jury, in the county; and in London, by the lord mayor, aldermen, and common council; nor shall any petition be presented by more than ten persons at a time.

**PETRIFACTION**, the conversion of wood, bones, and other substances, principally animal or vegetable, into stone. But how this is effected cannot be distinctly unfolded; all that we know certainly, is that the original mass is replaced by earthy or mineral particles. Thus on the north side of the river Eske, a short distance above the paper-mill at Penicuik, near Edinburgh, where the strata usually accompanying the coal formation of this country are exposed, a large portion of the trunk, and several roots, of a fossil tree, are visible. It rises several feet above the bed of the river, as far as the strata reaches, and the roots spread themselves in the rock. It appears as if the tree had actually vegetated on the spot where we now see it. It is, where thickest, about four feet in diameter. The strata, in which the remains of the tree stand, are slate clay, and the tree itself is sand-stone. There is sand-stone below and immediately above the slate clay, and the roots do not appear to have penetrated the lower sand-stone, to which they reach. Small portions of coal were observed where the bark existed, the form of which is distinct on the fossil. Whilst sinking a pit, in 1818, at Mr. Fenton's colliery, near Wakefield, Yorkshire, the workmen, having dug to the depth of eighty-six yards, came to a bed of coal two feet six inches thick, beneath which they found a petrified tree, or rather plant, having no branches, standing upright, but rather inclining to the east. It was six inches diameter at the top; but, as they sunk down, it increased to twelve inches, and at the depth of forty-two feet, seemed to branch out roots to another bed of coal six feet thick. The body was a gray sand-stone, coated round with a black carbonized matter one-tenth of an inch, supposed to be its bark. A species of siliceous fossil wood was found by a sergeant of artillery, who accompanied Captain Sabine, near the top of a hill in Hare Island, on the west coast of Greenland, in latitude 70° 26′. It had been a part of the trunk of a pine tree, about four inches in diameter. The hill is in the interior of the island, about four miles from the shore, and is considerably more than 900 feet above the level of the sea.

In the paper called the General Evening Post, for March the 17th, 1818, there is an account that had been then received at the Admiralty, of an interesting discovery made in the south of Africa, about twenty miles north of Cape Town. Some persons, in digging, happened to strike upon what appeared a beam of timber; but, tracing it, they found a ship deeply imbedded in the soil. A plank of it has accompanied the account of the discovery to the Admiralty. Several other ships, at different times, and in different parts of the world, have been discovered beneath the surface of the earth. It is recorded by Fulgosas, that in the year 1462, as some men were working a mine near Berne, in Switzerland, they found a ship 100 fathoms deep in the earth, with anchors of iron, and sails of linen, and the remains of forty men. Pairre Naxis relates a like history of another such ship having been found under a very high mountain. The Jesuit Eusebius Newcombergus, in his fifth book of Natural History, says, that near the port of Lima, in Peru, as the people were working a gold mine, they found a ship, on which were many characters very different from ours. Strabo also relates, in his first book, that the wrecks of ships have been found 375 miles from sea. Dr. Plott, in his Natural History of Staffordshire, relates a story, that the mast of a ship, with a pulley hanging to it, was found in one of the Greenland mountains. Is it to be supposed that these ships, which have been found beneath the surface of the earth, were antediluvian ships?

In the parish of Motterton, in the Isle of Wight, bones, which are supposed to belong to one of the mammoths, were discovered. Several of the vertebræ, or joints of the backbone, measure thirty-six inches in circumference: they correspond exactly in form, colour, and texture, with the bones of a similar kind found on the banks of the Ohio in North America. Also, in the parish of Northwood, on the north side of the island, the bones of the crocodile have recently been found by the Rev. Mr. Hughes of Newport. They seem to have belonged to an animal of that species, whose body did not exceed twelve feet in length. Their calcareous nature is not altered; but the bones of the mastodon (found on the south side of the island) contain iron. A considerable quantity of bones of a large size were lately discovered buried in the earth, in the neighbourhood of the village of Tiede, near Brunswick. They were examined by M. Dahne, who appears to have distinguished parts of the skeletons of five elephants. There were nine tusks among them, one of which was fourteen feet in length, another eleven, and many grinders, in which the enamel was arranged exactly as in the teeth of the African elephant. A complete head of a rhinoceros, with the horn and teeth, was also found very little altered, and likewise the horns of two kinds of stags. Mr. Dahne, in endeavouring to account for this accumulation of bones belonging to different animals, supposes that the animals existed in immense islands; that some great revolution of the globe inundated their habitations, and forced them to the highest spot for shelter from the waters; that, the waters still rising, they all perished together; that the perishable parts of their carcases were carried away by the waters, and that an earthy deposition soon enveloped the bones, and left them nearly in the state they are now found.

Mammoths' and elephants' bones and tusks are found throughout Russia, and more particularly in Eastern Siberia and the Arctic marshes. The tusks are found in great quantities, and are collected for the sake of profit, being sold to the turners in the place of the living ivory of Africa, and the warmer parts of Asia, to which it is not at all inferior. Towards the end of the month of August, when the fishing season in the Lena is over, the Tungusians generally go to the peninsula of Tamut, where they employ themselves in hunting, and where the fresh fish of the sea offer them a wholesome and agreeable food. One day, their chief, Schumachof, perceived among the blocks of ice a shapeless mass, not at all resembling the large pieces of floating wood, which are commonly found there. The following year (1800) he found the carcase of a walrus (*Trichechus rosmarus*.) He perceived, at the same time, that the mass he had before seen was more disengaged from the blocks of ice, and had two projecting parts, but was still unable to make out its nature. Towards the end of the following summer (1801,) the entire side of the animal, and one of his tusks, were quite free from the ice. But the summer of 1802, which was less warm, and more windy than common, caused the mammoth to remain buried in the ice, which had scarcely melted at all. At length, towards the end of the fifth year (1803,) the ardent wishes of Schumachof were happily accomplished; for the part of the ice between the earth and mammoth having melted more rapidly than the rest, the plane of its support became inclined, and this enormous mass fell, by its own weight, on a bank of sand. In the month of March, 1804, Schumachof came to his mammoth; and, having cut off his horns (the tusks) he exchanged them with the merchant Bultunof for goods of the value of fifty rubles. Two years afterwards, a Mr. Adams, traversing these distant and desert regions, found the mammoth still in the same place, but altogether mutilated. Wild beasts, such as white bears, wolves, wolverines, and foxes also, fed upon it; and the traces of their footsteps were seen around. The skeleton, almost entirely cleared of its flesh, remained whole, with the exception of one fore-leg. The spine from the head to the os coccygis, one scapula, the pelvis, and the other three extremities, were still held together by the ligaments and by parts of the skin. The head was covered with a dry skin; one of the ears, well preserved, was furnished with a tuft of hairs. Accounts from the banks of the Mississippi state, according to the Philosophical Magazine, that the mammoth has been discovered actually in existence in the western deserts of North America. According to the descriptions given of it, this colossus of the animal kingdom is not carnivorous, but lives on vegetables; more particularly on a certain species of tree, of which it eats the leaves, the bark, and even the trunk. It never lies down, and sleeps leaning for support against a tree. It has rather the shape of a wild boar than of an elephant, and is fifteen feet high. His body is covered by a hairy skin, and he has no horn.

**PETROLEUM**, is a fluid bitumen, of somewhat greater consistency than naphtha, of black, brown, or sometimes dingy green colour. By exposure to the air it assumes the consistence of tar, and is then called *mineral tar*. This substance exudes spontaneously from the earth, or from clefts of rocks, and is found in nearly all countries, particularly in the East Indies, Italy, France, Spain, Germany, and England. In the neighbourhood of Rangoon, in Pegu, there are several hundred wells of petroleum. These are of square form, and each lined with cassia wood staves. The property of the wells is in the proprietors of the soil, for whom they have been sunk, and are wrought. Some of the wells are of great depth. The oil is drawn from them pure, and in a liquid state, and is conveyed from thence in small jars. The whole annual produce of this district is estimated at more than 400,000 hogsheads. At Colebrook Dale, in Shropshire, there is a considerable spring of petroleum, which was discovered at the depth of about thirty yards beneath the surface of the earth, in digging an archway for the conveying coals from a very deep pit. It was at first found to ooze from between the crannies of the rock, but it soon afterwards poured forth in a considerable stream. The utility of this fluid being known, large iron pipes were formed for the conveyance of it into pits sunk for the purpose of receiving it. From these pits it is conveyed into immense caldrons, in which it is boiled until it attains the consistency of pitch. Since the first discovery of this substance, three different springs of it have broken out. One of these is near the celebrated iron bridge, and the fluid that issues from it is almost pellucid, but at the same time is thicker than treacle. Petroleum easily takes fire, and in burning yields a strong, sharp, and somewhat unpleasant odour; a thick and disagreeable smoke. In cold weather it congeals in the open air. In Pegu, and other parts of the East, petroleum is used in place of oil for lamps. Boiled with a species of resin, it is employed for painting the timber of houses, and covering the bottoms of boats and other vessels. In the latter respect it is considered to be particularly efficacious, by protecting the timber from the attacks of marine worms. It is also used by the inhabitants of Eastern countries as a lotion in cutaneous eruptions, and as an embrocation in bruises and rheumatic affections. The ancient Egyptians used it in the embalming of dead bodies. In some countries lumps of earth are soaked with petroleum, and are employed as fuel.

*Mineral Tar*, or *Barbadoes Tar*, is a kind of fluid bitumen, somewhat thicker than petroleum, and nearly of the consistence of common tar. It is viscid, of a black, brownish black, or reddish colour. In burning, its smell is disagreeable, but less pungent than most of the other kinds of bitumen. Its weight is somewhat greater than that of water. In the West Indies, where this substance is principally found, it is applied to many of the purposes for which the preceding species is used; but its principal repute is considered to be as a sudorofic in disorders of the breast and lungs, though this application of it is considered to be very improper. It is likewise used as an external remedy in paralytic disorders.

**PETROMYSON**, the *Lamprey*, a genus of fishes belonging to the class of amphibia nantes, of which there are eight species. The great lamprey is usually of a brown olive colour, tinged with yellowish-white. It is often three feet long, is an inhabitant of the seas, as its name indeed implies; but in the beginning of spring ascends rivers, in which it resides for a few months, then returning to the ocean. It is viviparous. These fishes fasten themselves with the jagged edges of the mouth to large stones, with the most extraordinary firmness, and may be lifted with the tail to a considerable height, without being made to quit a stone of the weight of even ten or twelve pounds. Their principle of vitality is extremely vigorous and persevering, various parts of the body long continuing to move for some hours after it is divided; and the head will adhere to a rock for hours after the greater part of the body is cut away. In some large rivers of Europe these fishes are taken in vast numbers, and preserved with spices and salt as an article for merchandise. In this country the Severn is the most celebrated river for them, and they are much valued on their first arrival from the sea. They are considered a high luxury for the table, and the life of one of the kings of England will be recollected to have been terminated by his excessive partiality to potted lamprey. The lesser lamprey is about twelve inches long, inhabits also the sea, but is found more frequently in the rivers than the former. It abounds in the Thames and Severn, and is preferred by many to the larger species, as being not so strong in taste. In some years half a million of these fishes have been sold from the neighbourhood of Mortlake, for the Dutch cod and turbot fishery, at the rate of two pounds per thousand.

**PETTY BAG**, an office of Chancery, the three clerks of which record the return of all inquisitions out of every county, and make all patents of comptrollers, gaugers, customers, &c.

**PETUNSE**, one of the substances of which porcelain is made, being a kind of coarse flint or pebble.

**PEUCEDANUM**, or SULPHURWORT, a genus of plants belonging to the pentandria class, and in the natural method ranking under the 45th order, Umbellatæ.

**PEWTER.** An alloy of lead and tin in the proportion of two parts of lead and one of tin, forms the *solder* which is used by plumbers; and, in the proportion of one part of lead to three parts of tin, it constitutes what is called *ley pewter*. The *types* which are used by printers for very large characters, are sometimes composed of an alloy of lead and copper.

**PHÆTON**, the *Tropic Bird*, in Natural History, a genus of birds of the order anseres, of which there are three species. The common tropic bird is of the size of a widgeon, and the two middle feathers of the tail measure 1½ feet at least. These birds are always found within, or at least, very near, the tropics. They frequently soar to a prodigious height, but generally are near the surface of the water, watching the movements of the flying fish, whose escape from the pursuit of the shark, porpoise, and other enemies beneath, is attended with destruction from the frigate or man-of-war bird, the pelican, and tropic bird, above. They occasionally repose upon the backs of the drowsy tortoises, as the latter float upon the water, and in these circumstances are taken with the greatest ease. They build in the woods, and will perch on trees. They shed their long feathers every year, and the natives of the Sandwich Islands, where the tropic birds abound, pick them up in great abundance in various parts, and consider them as an elegant material in their curious and elaborate dresses, particularly in their mourning suits. These birds are not admired for food.

**PHALANX**, in Grecian antiquity, a square battalion, consisting of 8000 men, with their shields joined, and pikes crossing each other, so that it was next to impossible to break it.

**PHALENA**, MOTH, a genus of insects of the order lepidoptera. This genus, like that of papilio, containing a vast number of species, is divided into assortments according to the different habits of the animals.

**PHANTASMAGORIA**, denotes a remarkable optical illusion, arising from a particular application of the magic lantern. In the exhibition of this spectacle, the audience are placed in a dark room, having a transparent screen between them and the lantern, which screen ought to be let down after the lights are withdrawn, and unknown to the spectators. The lantern being then properly adjusted on the opposite side, the figure intended to be exhibited is thrown upon the screen, which will appear to the observers as if placed in free space, and by altering the distance of the lantern, the figure may be made to appear of any size; which changes in its dimensions are attributed, by the observers, to the distance or proximity of the image, so that at one time it appears to be at an immense distance, and at another to be exceedingly near, and over the heads of some part of the audience. The following is a description of the exhibition of this spectacle, as shewn at the Lyceum theatre, London:—All the lights of the small theatre of exhibition were removed, except one hanging lamp, which could be drawn up so that its flame should be perfectly enveloped in a cylindrical chimney, or opaque shade. In this gloomy and wavering light the curtain was drawn up, and presented to the spectator a cave or place exhibiting skeletons, and other figures of terror, in relief, and painted on the sides or wall. After a short interval, the lamp was drawn up, and the audience were in total darkness, succeeded by thunder and lightning; which last appearance was formed by the magic lantern, upon a thin cloth or screen, let down, after the disappearance of the light, and consequently unknown to most of the spectators. These appearances were followed by figures of departed men, ghosts, skeletons, transmutations, &c. produced on the screen by the magic lantern on the other side, and moving their eyes, mouth, &c. by the well-known contrivance of two or more sliders. The transformations are effected by moving the adjusting tube of the lantern out of its focus, and changing the slider during the moment of confused appearance. It must be again remarked, that these figures appear without any surrounding circle of illumination, and that the spectators, having no previous view or knowledge of the screen, nor any visible object of comparison, are each left to imagine the distance according to their respective fancy. After a very short time of exhibiting the first figure, it was seen to contract gradually in all its dimensions, until it became extremely small, and then vanished. This effect, as may easily be imagined, is produced by bringing the lantern nearer and nearer the screen, taking care at the same time to preserve the distinctness, and at last closing the aperture altogether, and the process being (except as to brightness) exactly the same as happens when visible objects become more remote, the mind is irresistibly led to consider the figures as if they had receded to an immense distance. Several figures of celebrated men were thus exhibited with more transformations; such as the head of Dr. Franklin being converted into a skull, and these were succeeded by phantoms, skeletons, and various terrific figures, which, instead of seeming to recede and then vanish, were (by enlargement) made suddenly to advance, to the surprise and astonishment of the audience, and then disappear by seeming to sink into the ground.

**PHARMACY**, the art of preparing, compounding, and preserving medicinals. The preservation of medicines merely consists in the application of rules for collecting vegetable, animal, and mineral productions, at certain seasons or under particular circumstances, and of ensuring them against the injuries they would suffer by exposure to light, heat, air, moisture, &c. this, therefore, is the least extensive, and peculiar department of the pharmaceutic art. It is the preparation and

Fig. C

Fig. B

Fig. A.

Fig. H.

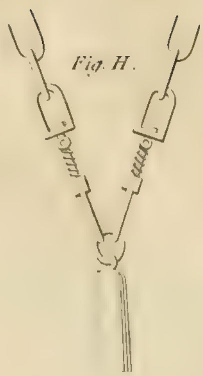


Fig. G.

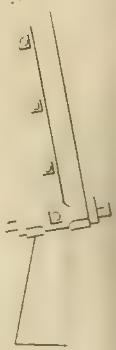


Fig. B.

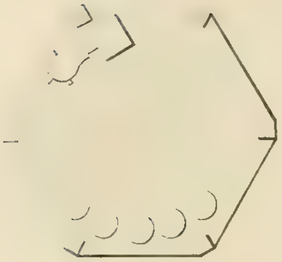


Fig. C

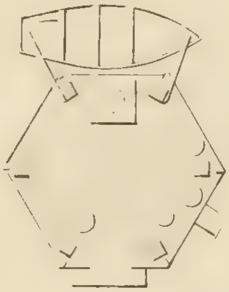


Fig. D.

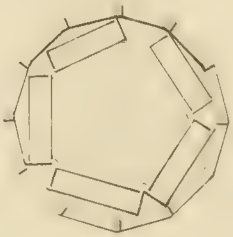


Fig. E.

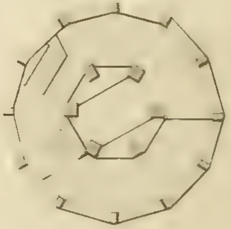


Fig. F.

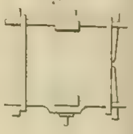


Fig. 2.

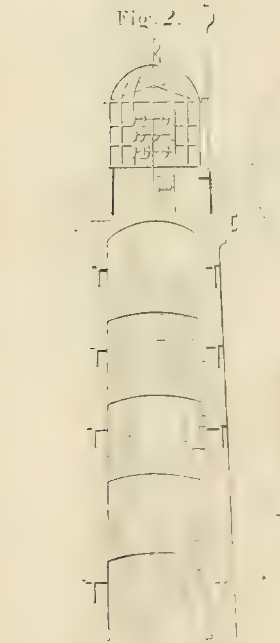


Fig. K.

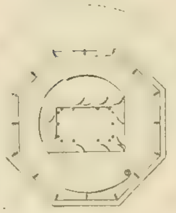


Fig. 1.

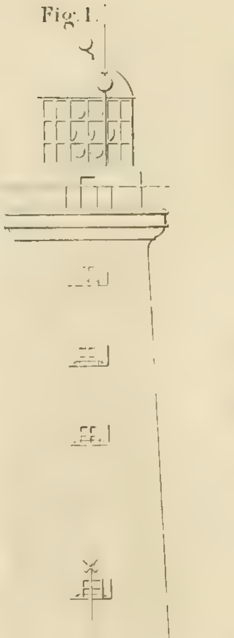


Fig. D.

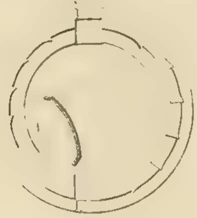


Fig. H

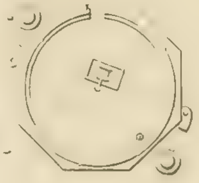


Fig. E.

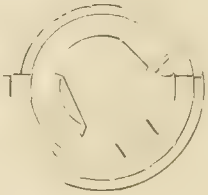


Fig. G

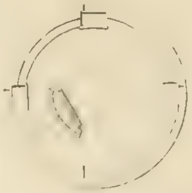


Fig. F

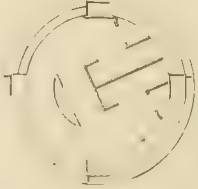
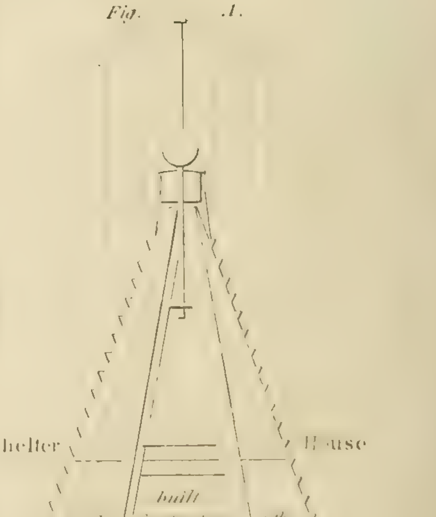


Fig. A.



composition of medicinals that constitute the principal objects of the science of pharmacy.

**PHARO**, is the name of a game of chance, the principal rules of which are: the banker holds a pack consisting of 52 cards; he draws all the cards one after the other, and lays them down alternately at his right and left hand, then the ponte may at his pleasure set one or more stakes upon one or more cards, either before the banker has begun to draw the cards, or after he has drawn any number of couples. The banker wins the stake of the ponte when the card of the ponte comes out in an odd place on his right hand, but loses as much to the ponte when it comes out in an even place on his left hand. The banker wins half the ponte's stake when it happens to be twice in one couple. When the card of the ponte being but once in the stock, happens to be the last, the ponte neither wins nor loses; and the card of the ponte being but twice in the stock, and the last couple containing his card twice, he then loses his whole stake.

**PHAROS**, A LIGHT HOUSE. (See the Plate.) The Pharos of Alexandria, built on a small island at the mouth of the Nile, was in ancient times so famous as to impart its name to all the rest. It was erected by the much celebrated Sostrates, with such great magnificence, that it is said to have cost Ptolemy Philadelphus eight hundred talents. It had several stories raised one over another, adorned with columns balustrades, and galleries, of the finest marble and workmanship. At present nothing is to be seen of the small island where it stood, but an irregular castle, without ditches or outworks of any strength. Out of this clumsy building rises a tower, which serves for a light-house, but the grandeur of the old one has totally disappeared. The famous Colossus of Rhodes served also as a pharos. But as those which have been erected in more modern days, on the shores of our own country, are far more interesting, we purpose giving, under the present word, an account of the erection of the Bell Rock light-house.

England, which is never behind in deeds of mercy, very early attempted, by the erection of the Eddystone light-house, to ward off the dangers of the sunken reef of rocks on which so many vessels have been shipwrecked, and which rendered the navigation of the channel so very hazardous: and Scotland, whether we consider the dangers to be prevented, or the difficulties to be overcome in the execution, can now boast in the Bell Rock light-house, a national work, equal in every point of view to any in the world. If, therefore, England has adorned the name of Smeaton with honours, which it is to be hoped will prove immortal, Scotland ought equally to glory in that of Stevenson.

The reef of rocks on which the Bell Rock light-house is founded, is about 427 feet long and 230 feet broad; at the ordinary height of spring tides it is about 12 feet under water; and from the floating sea-weed, the ridge can be traced 1000 feet farther in a south-westerly direction, when the tides are very low. It is situated on the eastern coast of Scotland, about 16 miles S. by E. from the Red-head; 12 miles SE. from Arbroath; 17 miles N. by E. from the Isle of May; and 38 miles N. by W. from St. Abb's-head. Its geographical position is in 56° 29′ of north latitude, and 2° 22′ of west longitude. The reef presents an exceedingly rugged and uneven surface. The rock is composed of red sand-stone similar to the strata of the contiguous promontory of Red-head, and of the opposite shores of Dunglas in Berwickshire. The present vegetation of the rock consists only of sea plants; some of them not of common occurrence on our coast. It is the occasional resting-place of the seal and the cormorant; and is the chosen residence of numerous marine *vermes*. At the distance of 100 yards, when the tide is low, the water varies from two to three fathoms in depth. The greatest depth between the rock and the opposite shores of Fife is 23 fathoms. This rock, though a mere spot on the surface of the ocean, produces all the remarkable phenomena of in-shore and off-shore tides, which exist on the projecting coasts of the mainland, or among the Scottish islands.

In the erection of the Eddystone light-house, the dangers and difficulties which were encountered and overcome, owing to the smallness of the surface of the rock, were great and numerous; and although the surface of the Bell Rock was considerably larger, still, being more sunk, and only discovered at low water, the dangers to be encountered were equally great and overwhelming. Owing to the enlarged diameter of the rock, Mr. Stevenson, the engineer, was enabled to make the masonry of this building more than double the cubical contents of the Eddystone.—The following short table will exhibit to our readers the relative dimensions, &c. of the two light-houses:—

| | *Eddystone.* | *Bell Rock.* |
|---|---|---|
| Height of the rock, about | Level with high water mark. | Level with low water mark. |
| Height of masonry above the rock ............ | 70 feet. | 100 feet. |
| Diameter of the first entire course........... | 26 feet. | 42 feet. |
| Cubic contents in feet, about................. | 13,147. | 28,530. |
| Expense understood to have been about...... | £21,000. | Ascertained. £61,331. 9s. 2d |

Very early, no doubt, attempts were made to obviate the dangers of this fatal spot; and accordingly, tradition reports, that the monks of the Abbey of Arbroath erected a bell on the rock, which was to be rung by machinery affected by the flowing and ebbing of the tides, whence the present name of the rock, it is said, took its rise.

About the year 1800, the board of commissioners of the northern light-houses, a body organized in 1788, and to whose labours, which are purely *ex officio*, and without any renumeration whatever, the country is under the greatest obligations, being desirous of erecting a light-house on the Bell Rock, requested Mr. Stevenson, their engineer, to survey the spot. He did so, and reported that he conceived it quite practicable to erect one on the plan of the Eddystone light-house. His first landing on the rock was in the summer of 1800, when the boat's crew picked up a variety of articles of shipwreck, comprising a soldier's bayonet, a cannon ball, a hinge and lock of a door, a ship's marking iron, and part of a compass, several pieces of money, a shoe-buckle, &c.

In the year 1803, a bill for the erection was brought into parliament, but was lost in consequence of its being considered that it embraced too wide a range of coast for the collection of the duty. In the year 1806, another bill was introduced into parliament, and passed into a law. This act provided for a loan to the board of £25,000; and as there were surplus duties to the amount of £20,000 in the hands of the commissioners, the work commenced in 1807, with funds to the amount of £45,000.

From the insulated and distant situation of this rock, the first object of the engineer was to provide a convenient residence for the artificers, while engaged at the work. This was done by mooring a tender off the rocks, and on it a temporary light was exhibited. A vessel was provided for conveying the workmen between the shore and the rock. The outer casing of the building was to be of Aberdeen granite, and the internal part of sand-stone. Quarries were opened near Aberdeen for supplying the one, and at Ringoodie, near Dundee, for supplying the other. The principal establishment on the shore was at Arbroath, where a large yard was enclosed for the purpose of preparing the stones. Barracks were likewise erected for the residence of the workmen when on shore.

It was on the 7th of August 1807, that Mr. Stevenson accompanied by Mr. Peter Logan, his principal assistant, and a few workmen, went off to the Bell Rock, and fixed on the site of the building. They immediately commenced their operations, by cutting away a thick coating of large sea-weed, and tracing the line of the foundation with pick-axes on the rock. At this time it was agreed on, that those workmen who went out to the rock should remain for a month without going ashore. They, on the other hand, fixed their terms at 20*s*. per week, "summer and winter, wet and dry, with free quarters and victuals when at the rock." Premiums, and the allowance they were to receive for working on Sundays, "they left to the honour of their employers."

At the commencement of this arduous undertaking, two or three hours' labour on the rock was considered a very good tide's work: and the men were then obliged to collect their tools and implements, betake themselves to the boats, and, often under great disadvantages and with considerable risk and danger, seek refuge in the tender which was moored off the rock. To provide a temporary refuge for the workmen on the rock, in case of any accident happening to the boats, formed part of Mr. Stevenson's original design, and he accordingly lost no time in setting about the construction of a wooden beacon or shelter-house, which we have represented in figure A. This most necessary place of refuge was triumphantly completed in the latter end of September, and, as Mr. Stevenson says, "robbed the rock of much of its terrors, and gave a facility to the works which could not otherwise have been easily obtained." The erection of this temporary shelter-house forms an exceedingly interesting part of the history of this altogether interesting undertaking. Six beams, about 50 feet in length, were fixed upright on the rock, inclosing a space, the diameter of which was 35 feet, while they met in a point at the top. They were fixed at their base by great iron staunchions, weighing about 140 lb. each, which were sunk into the rock about 20 inches, and were wedged with successive slips of fir, oak, and iron: at the top the beams were bolted together, and strongly fastened by hoops of iron, see fig. (*first*) G. The works at this stage depended entirely, it may well be supposed, on the state of the weather: they were obliged therefore to work on Sundays, and by torch-light at night, when the tide permitted. The work was thus carried on under circumstances of peculiar hazard, and several very narrow escapes were made.

The sloop Smeaton, which was used as a tender, at one time broke adrift from her moorings, carrying with her one of the artificers' boats, and from the current of the tides it was utterly impossible she could return until after the rock would be overwhelmed by the sea. At this time there were 32 men on the rock, and the two boats which were left would hold little more than half that number, especially in such a heavy sea. This accident of the breaking loose of the tender, and carrying away of the boat, was only known to Mr. Stevenson and the landing-master: the workmen, sitting or kneeling at their work in the foundation pit, were in perfect ignorance of their perilous situation, till the rise of the sea drove them from the works, and made them seek their respective boats for their jackets and stockings. Their dismay and consternation on beholding two boats only instead of three, must have been great; yet "not a word," says Mr. Stevenson, "was uttered by any one, but all appeared to be silently calculating the numbers, and looking to each other with evident marks of perplexity depicted on their countenances." A pilot-boat, however, bringing letters from Arbroath to Mr. Stevenson, fortunately arrived at this dreadful juncture, and thus being all relieved from the rock, they set sail in search of the tender, which they reached, and got safely on board of, though after a most dreadful passage, in which Mr. Stevenson's face and ears were encrusted with a film of salt from the sea-spray breaking over the bows of the boat.

In the progress of the works in the summer of 1808, a considerable addition was necessary to the shipping establishment. Besides the floating light-ship which had been moored off the rock, a schooner of 80 tons was provided as the principal tender. Stone-lighters of 40 tons were also provided for the conveyance of materials; and three praam boats, each capable of carrying about 10 tons upon deck. These last were employed for removing the stones from the lighters anchored off the rock to the wharfs and cranes on the rock. They were doubly fortified by a water-tight ceiling, or lining, in case of damage by being grounded upon the rock, and were farther prepared for the worst by a number of empty casks, which were stowed under deck, and were of themselves capable of keeping the praams afloat. There were also several attending boats for transporting the artificers from the tender to the rock, and one of them was fitted up as a life-boat upon Gratehead's principle. The moorings of the various craft consisted of chains, with cast-iron mushroom anchors, admirably adapted to the situation. Tracks of iron railways were laid upon one level, along the rough and uneven surface of the rock, on which the great blocks of stone were wheeled upon waggons also constructed chiefly of cast-iron. The little wharfs were provided with cranes adapted to the peculiarities of the respective situations. A descriptive account is given by Mr. Stevenson, in his work, of the various cranes, sling-carts, stone-jack, winch-machine, and Lewis-bat for quarrying purposes, of the moulds for stone-cutters, pumps, and other machinery, in a detailed manner, extremely interesting to the engineer and the architect.

At first, the whole time of flood-tide was a period of leisure. During such periods, the amusements to which the men resorted were as various as their inclinations. Some, fond of reading, were busily engaged at their books; some, who were more musically inclined, played the violin or the flute; and others amused themselves by fishing. The great evil, however, of which they all complained, and which time itself hardly cured, was sea-sickness. Every nerve was therefore strained to erect barracks for their accommodation upon the beams on the rock, which was at once to relieve them from the constant liability to sickness, and from the danger and perplexity of the movements, both by night and day, in boats to and from the rock.

By strenuous and unremitting exertions, the shelter-house was erected, and the foundation-pit of the building prepared, by the middle of the month of July, in this the second season of the work. The foundation had the appearance of a great circular platform, of compact red sand-stone, measuring 42 feet in diameter, surrounded by an irregular margin of rock, rising from 18 inches to 5 feet. In the work-yard at Arbroath, where the materials were prepared, each stone for the first and second courses of the light-house was accurately marked, so that its relative position in the building on the rock could at once be recognized. The stones were cut of a dove-tail form, on a plan similar to those of the Eddystone light-house. This is very well represented in fig. (*first*) A, which exhibits one half of the second course of masonry.

The foundation stone at the Bell Rock was laid by Mr. Stevenson, with masonic ceremony, on the 10th of July, 1808. About eighty persons were present, and if the situation had been eligible, no doubt some thousands would have attended. After this period the work went on with much alacrity, from ten to twenty blocks of stone being generally laid in the course of a tide. Owing to the use of cranes instead of the mere ordinary apparatus, much precision and facility were given to the operations of the builders, and by the latter end of September the works were brought to a conclusion for the season. The building raised to a level with the highest part of the margin of the foundation-pit, or about five or six inches above the lower bed of the foundation-stone, was computed at 388 tons of stone; consisting of 400 blocks connected with 738 oaken trenails, and 1215 wooden wedges. The number of hours of low-water work upon the rock, this season, was 265, of which number only 80 were employed in building. It was, farther, highly satisfactory to find that the apparatus, both in the work-yard at Arbroath and also the craft and building apparatus at the rock, were found to answer every purpose much beyond expectation. The operations of this season, therefore, afforded the most flattering prospects of the practicability of completing the solid part of the building, or 30 feet of the light-house, in the course of another year. The builders returned to their barracks, and work-yard at Arbroath, for the winter; and, on the tender's entering that harbour, the artificers were greeted with cheers from their friends and comrades on shore, who thronged upon the quays to welcome their return. This season's success, however, was chequered with a cross accident, in the loss of a sailor from one of the stone-lighters.

In the spring of 1809 the operations recommenced; and the building, during the course of this season, advanced with great rapidity. The winter storms had done no injury; the whole of the courses which had been laid, and the shelter-house itself, was, in the third year from its erection, remaining quite secure. The artificers, from this tried stability of the shelter-house, were rendered more confident, and more impatient of the trouble and inconvenience attending landing and re-landing on the rock from the tender: and, therefore, before it was quite fitted up for a barracks, they took possession of it through the day. One evening, however, a gale of wind preventing the boats from taking them off, Mr. Peter Logan, and Mr. Francis

Watt, two of the overseers at the rock, with eleven of the artificers, were necessarily left there for 30 hours, while very often the waves washed over their yet imperfectly formed abode: the mortar gallery below them was carried away by the violence of the storm, and one of the cranes was broken to pieces. Hitherto the operations of the builders were wholly confined to the lower-water work. From the great exertions, however, made by the shipping department in supplying materials this season, the builders were enabled to lay 30 blocks of stone in the course of a tide.

When the building had attained the height of the ninth course, the guy ropes of the usual description of beam crane, became too upright, and it was found necessary to resort to other measures. A new machine, called a Balance Crane, was therefore put in preparation for the use of the works next season. In this, the upright shaft was to be retained in an erect position, by a weight acting on the opposite end of the loaded beam, which was thus to be kept *in equilibrio*.

The light-house now began to appear considerably above the rock at low-water; and the tide's work, in moderate weather, extending to five or six hours, or an hour or two after the rock was under water. The shelter-house was now fully occupied as a barrack, smithy, and mortar gallery; and between this fabric and the rising walls of the light-house, a rope ladder of communication was distended.

Upon Sunday, the 20th of August, this year, the entire twenty-second course of the building, consisting of 51 blocks, was laid; after which, for the first time, prayers were read in the shelter-house, the whole workmen being assembled in one apartment, and two of them joining hands to form a desk to support the Bible during the service. On the 25th of this month, the building operations were brought to a conclusion for the season.

At the commencement of the works in spring, 1810, a great stock of prepared materials was in readiness at Arbroath, excellent sand-stone having been procured from Milnefield Quarry, on the Frith of Tay. The stones for the cornice and light-house, from Craigleith, near Edinburgh, were likewise prepared, and in readiness for shipping at Leith. A large gangway or bridge of timber had been prepared during the winter, to render the communication between the shelter-house and light-house more perfect, than by means of the rope ladder; and which was calculated to be of great use for raising the materials upon the building.

The first circumstance attended to, in commencing the operations of this season, was to fix upon the proper situation for the door of the light-house; and the heaviest seas being determined to be from the north-east, the door was laid off towards the south-west. The first cargo of stones was brought to the rock about the middle of May; and from the very complete and systematic arrangement of the works, the building operations were brought to a close during the month of August, without any material obstacle having been experienced. This increased facility in building was ascribed partly to the experience acquired by practice during former seasons, and partly to the admirable adaptation of the balance crane, formerly mentioned, for laying the stones on their places upon the building. The works were, however, occasionally interrupted, by the shipping being dispersed in gales of wind, when they were sometimes driven upwards of forty miles from their station. At such times, the artificers were closely cooped up in their barrack upon the rock, in a state of painful inactivity, and often with prospects very forlorn. It is certainly not a little remarkable, that in the course of their extensive operations, not a single stone was lost, or even so damaged as to be rendered unfit for the building, notwithstanding the numerous changes and shiftings from hand to hand, which each stone underwent before it was finally laid with mortar. In some instances, indeed, blocks of stone were lifted from their beds by the run of the sea; but none were carried entirely away.

In the engravings, we have given an elevation, plan, section, and details of the light-house. The lower courses of stones were trenailed and wedged together with oak timber to the height of upwards of forty feet, or throughout the solid part of the building. At the stone staircase, leading from the door to the first floor, the walls are of the medium thickness of about seven feet; this thickness gradually diminishes upwards, till, under the cornice of the building, it extends only to 18 inches. The stones of the walls of the several apartments are connected at the ends with dove-tail joints, instead of square joggles, as in the solid, and in the staircase. The floors are constructed in a manner which adds much to the bond or union of the fabric. Instead of being arched, which would have given a tendency or pressure outwards, on the walls, the floors are formed of long stones, radiating from the centre of the respective apartments, and at the same time, forming a course of the outward wall of the building; these floor stones are also joggled sidewise, and, upon the whole, form a complete girth at each story. This is very well seen in figures K and H. In this manner, the pressure of the floors upon the walls is rendered perpendicular, while the side joggles resemble the *grove and feather* in carpentry, exemplified in figs. D, E, and F. In the stranger's room, or library, the roof takes an arched form, but the curve is cut only upon the interior ends of the stones of the cornice, the several courses of which it is composed being all laid upon level beds. This is seen in fig. 2.

Towards the latter end of August, the masonry was completed, and the operations of erecting the light-room commenced. The shelter-house, which had hitherto been crowded by more than 30 persons, during the summer, was now more thinly peopled. Towards the end of the month of October, the balance crane, and the bridge of communication were dismantled; the former was no longer necessary, and in place of the latter the rope ladder was again distended; the shelter-house being still occupied as the place of accommodation for the artificers employed in fitting up the light-roof and reflecting apparatus: seen in figs. 2, and K. In the month of December the keepers took possession of the light-house: about the middle of that month, the whole apparatus and stores, having been safely landed and lodged in the house, the light was advertised for exhibition on the 1st of February, 1811. On the afternoon of that day, it was accordingly exhibited; and the floating light was extinguished, as being no longer necessary.

Since the completion of the light-house, the shelter-house has been removed, and also part of the iron railways, leaving only such tracks of them upon the rock, as were thought necessary for landing the stores, and communicating with the light-house. Instead of a rope ladder, the communication between the rock and the entrance door, a height of about 30 feet was also formed by a brazen stair, which answered also for part of a thunder rod, and facilitated the raising of the stair, by a peculiar sort of crane adapted to the purpose. The fortunate position of the entrance door rendering it seldom necessary to shut it in summer, an inner door of brass has been hung, which is found to be a great conveniency to the inmates. During storms, when their double doors, double windows, and storm shutters, are closed, the light-keepers mention that they occasionally feel a tremor in the building, from the shocks of the sea, but that all is quiet within, and they hear nothing of the dashing and roaring noise of the sea.

We shall now proceed to describe the details of the work as represented in the various engravings on the plate:—

Fig. (*second*) A, the shelter-house used as a barrack, consisted of several stories, *viz.*

Fig. (*second*) B, is the lower floor, or a gallery in which the smiths and mortar-makers latterly worked, with the position of the bellows, anvil, hearth, lime tubs, and mortar casks.

Fig. (*second*) C, represents the second floor of the cooking-room, the caboose or hearth, chimney, provision casks, and the life-boat suspended by davits from the principal beams of the shelter-house.

Fig. (*first*) D, is the ground plan of the fourth floor, in which the workmen resided; the five parallelograms shew the position of the beds, which were also ranged in five heights, excepting at the man-hole or place of entrance, where were only three.

Fig. (*first*) E, is the third floor, or foreman and engineer's cabins. Here also their assistants resided.

Fig. (*first*) F, represents one of the principal beams cut across at the clasp-plate, and the great iron stanchions and spear bolts that bound the whole together.

Fig. (*first*) G, represents part of one of the beams of the shelter-house connected with the great stanchions, with its bolts, which were fitted on each side of the beam; the clasp-plates and spear bolts that bound the whole, and fixed it to the rock, are plainly marked.

Fig. (*first*) H, is an enlarged view of two of the bracing chains, with their tightening shackle meeting in a strong ring attached to the massive iron batts sunk into the rock about 20 inches, and wedged with timber.

Fig. 1, is an outside view of the Bell Rock Light-house.

Fig. 2, is an entire section of the Pharos or Light-house, exhibiting its various stories and apartments, as represented in the following diagrams.

The literals A, B, C, D, E, F, G, H, K, are enlarged views of the several parts of the Pharos just now described.

Fig. (*first*) A, representing the first entire course of the masonry, measures 42 feet in diameter. The dove-tailed method of connecting the solid part of the Pharos here delineated extends to the height of the entrance door.

Fig. (*first*) B, the twenty-seventh course and first of the staircase, measures 6 feet 4 inches in diameter, within the walls, and 19 feet 8 inches over the walls. This course is elevated 32 feet 8 inches above the rock at the foundation of the first stone.

Fig. (*first*) C, the thirty-ninth course of the building and first of the provision store-room, is 45 feet 11 inches above the foundation; 11 feet 9 inches diameter within walls; 18 feet over walls; and from the floor to the roof, the height is 8 feet 7 inches.

Fig. (*second*) D, is a plan of the floor of the light, or oil room store, being the forty-eighth course, which is 55 feet 10 inches above the foundation. This apartment, within walls, measures 11 feet 10 inches; over walls, 16 feet 10 inches; and its height is 8 feet 7 inches.

Fig. (*second*) E, being the kitchen floor, forms the fifty-seventh course, which is elevated 65 feet 8 inches above the foundation. This room is 11 feet 11 inches in diameter within, over all 16 feet; and its ceiling is 8 feet 9 inches high.

Fig. (*second*) F, is the bed room floor, or the sixty-sixth course of the building, and is elevated 75 feet 8 inches above the foundation. It measures 11 feet 11½ inches diameter, and over all 15½ feet. The walls are 9 feet in height.

Fig. (*second*) G, the next in order, is the floor of the library or stranger's room, 85 feet 11 inches above the foundation. Its diameter within 12 feet, over walls 15 feet, and the height of the roof at the centre, is 11 feet 1 inch.

Fig. (*second*) H, the light room and balcony floor, or 86th course of the building, which is elevated 97 feet 9 inches above the foundation, measures 11 feet in diameter within, and 13 feet 6 inches over walls. The stones of the floor of this apartment, as will be observed in the engraving, extend from the centre stone to the circumference of the balcony, varying from 7 feet to 7 feet 6 inches in length. The parapet wall of the light room has its outward face octagonal, but is worked circular within. The light room measures from the floor to the top of the stone work, or sole of the glazed sash frames, 6 feet.

Fig. K, is a plan of the lantern, shewing the position of the trimming path, and reflector frame. The height of the pharos from the foundation to the sill of the sash frame, is 102 feet 6 inches, and from thence to the lining of the cupola, 13 feet 4 inches.

The net cost of the Bell Rock Light House, and ulterior works connected with that establishment, was £61,331. 9s. 2d. There were 2,083,445 tons of granite and sandstone used in the construction; 13 cubic feet of granite, and 14 cubic feet of sandstone, were allowed to the ton; 204 barrels of sand; 377 barrels of lime; 255 barrels of pozzolano; 6585 wedges of oak, in pairs; 4065 oak trenails; 450 sandstone joggles; 21,598 cubic feet of sandstone, and 6932 cubic feet of granite.

PHASEOLUS, *Kidney Bean*, a genus of the diadelphia decandria class of plants, the corolla whereof is papilionaceus, the vexillum is cordated, obtuse, emarginated, and reclined with reflex sides; the alæ are roundish, of the same length with the vexillum, and stand upon long ungues; the carina is narrow, and revolves spirally in a contrary direction to the sun; the fruit is a long, straight, coriaceous, and obtuse pod; the seeds are oblong, compressed, and kidney-shaped. There are 21 species.

PHASES, in Astronomy, denote the various appearances of the moon at different ages, being at one time a crescent, then a semicircle, then gibbous, and lastly full; after which, the same phases return again in the same order. Venus and Mercury have the same phases as the moon, and Mars partakes of them, in some measure, being at times gibbous; the same must also have place in a less degree with the other superior planets. The same term is also applied to denote the appearance of the moon or sun when eclipsed.

PHASIANUS, the *Pheasant*, in Natural History, a genus of birds of the order Gallinæ. Generic character: bill short, strong, and convex; head covered in some degree with carunculated flesh; legs generally with spurs. There are ten species. P. gallus, or the wild pheasant, inhabits the forests of India, and has been seen, indeed, by navigators in almost all the Indian and South Sea islands. This is the undoubted origin of all the domestic varieties throughout Europe, of which we shall notice the following:—P. gallus, or the dunghill cock. The most interesting animal under this variety is the game cock, which is found in greater perfection of vigour and courage in England than in any other country; and the irascibility and jealousy of which has, in almost all ages, occasioned it to be employed in the sanguinary diversion of cockfighting.

PHENOMENON, is strictly an appearance, but more commonly confined to those only of an extraordinary nature, particularly as relating to the heavens, or heavenly bodies; as comets, meteors, shooting stars, &c. We also speak of the phenomenon of the magnet, of electricity, &c.

PHILOLOGY, a science, or rather assemblage of several sciences, consisting of grammar, rhetoric, poetry, antiquities, history, and criticism.

PHILOSOPHER, a person well versed in philosophy, or one who makes profession of, or applies himself to the study of, those sciences.

PHILOSOPHY, the knowledge or study of nature or morality, founded on reason and experience, the word originally implying *a love of wisdom*. The only part of philosophy, however, which belongs to a work of this kind, is that which is called natural or experimental philosophy, and which may be generally defined that branch of science which derives its data from experiments and observations, on which the whole system is supported, as is that of geometry upon axioms and definitions.

*Natural* PHILOSOPHY, is the science that unfolds those general principles which connect the events of the material world. It assumes as a basis, the constancy and permanence of the actual state of things. The appearances which present themselves to our observations, are called *phænomena;* and the common relations which pervade these phænomena, are termed laws. The business of the natural philosopher is to ascend patiently from effects to causes, till he approaches the fountain of all power and intelligence; and from that eminence again to descend, and trace the lengthened chain of consequences. This double mode of procedure corresponds to the analysis and synthesis of the ancient Greek geometry. The analysis, or investigation of physical facts, is conducted, either by observation, or by experiment. Observation is the close inspection, and attentive examination, of those phenomena which arise in the course of nature. Experiment, as the term implies, consists in a sort of trial or artificial selection and combination of circumstances, for the purpose of searching after remote results. The main object of the philosopher is always to separate the various effects which are blended together in the ordinary concurrence of events. The primary facts being once detected from close observation, or delicate experiment, the synthetical deduction can be safely pursued by the exercise of a sober and cautious logic. But the most important instrument, in forwarding this process of combination, is geometry, to which indeed we are indebted for whatever is most valuable in physical science. The most satisfactory mode of proceeding in the exposition of the phenomena, is to consider bodies as (1) in a state of rest, and (2) in a state of motion. The essential properties which belong to each distinct body, form a branch of science that may be termed *Somatology*, but which has hitherto been styled incorrectly *Corpuscular Philosophy*.

A course of natural philosophy may be properly distributed under twelve distinct heads:—

1. *Somatology*, which includes the exposition of the general properties of bodies, essential to their separate existence.

2. *Statics*, which explains the equilibrium of bodies, resulting from their mutual action, or from combined pressure and divellence.

3. *Phoronomics*, or *Dynamics*, which explores the laws of motion, and traces the flux of changes produced by the application of force.

4. *Physical Astronomy*, which is the extension of dynamics, to develop the great phenomena of the heavens. It explains the figures and motions of the planets, and deduces their various effects.

5. *Mechanics*, in which the principles of dynamics descend to improve the vulgar arts, and to explain the composition and arrangement of the various machines contrived to assist the labour of man.

6. *Hydrostatics*, which consists in the application of the principles of statics to explain the equilibrium of liquids or of fluids in general. It treats also of the construction of works depending on such properties.

7. *Hydrodynamics*, or *Hydraulics*, which consists in applying dynamics to the motion of liquids. It consequently investigates the construction and performance of the various engines employed to raise water, or which are driven by the impulsion of that fluid.

8. *Pneumatics*, includes the application of statics and dynamics to air and other gaseous fluids. It explains the constitution, the operations, and general phenomena, of our atmosphere.

9. *Photonomics*, which treats of the properties and operations of light.

10. *Pyronomics*, which explores the properties and operations of heat.

11. *Magnetism*, which investigates the properties of the loadstone, and their application to the suspended needle.

12. *Electricity*, which explains all the brilliant phenomena derived from those first produced by the rubbing of amber.

Such appears to be the systematic arrangement of those subdivisions; but it will admit of being conveniently modified, according to the taste or judgment of philosophers.

PHLEGM, or WATER, in the animal economy, is considered an elementary body, the characters of which are fluidity, insipidity, and volatility.

PHLEUM NODOSUM. (*Bulbous Cat's-Tail-Grass.*) This grows very frequently in dry thin soils, where it maintains itself against the parching sun by its bulbous roots, which lie dormant for a considerable time, but grow again very readily when the wet weather sets in,—a curious circumstance, which gives us an ample proof of the wise contrivance of the great Author of nature, to fertilize all kinds of soil for the benefit of his creatures here below. There is another instance of this in the Poa *bulbosa*, Bulbous meadow-grass, which grows on the Steine at Brighton, and which, after being kept in papers two years out of ground, has vegetated afterwards.

PHLOAS, a genus of vermes testacea. The inhabitants of this genus perforate clay, spongy stones and wood, while in the younger state, and they increase in size, enlarge their habitation within, and thus become imprisoned. They contain a phosphorus liquor, of great brilliancy in the dark, and which illuminates whatever it touches. There are 12 species.

PHOCA, the *Seal*, in Natural History, a genus of mammalia of the order feræ. There are nineteen species, of which we shall notice the following:—The common seal, or sea-calf, found on the sea coasts of cold regions, both to the north and south, often in extreme abundance, and generally about five feet in length, closely covered with short hair. They swim with great vigour and rapidity, and subsist on various kinds of fish, which they are often observed to pursue within a short distance from the shore. They possess no inconsiderable sagacity, and may without much difficulty, if taken young, be familiarized to their keepers, and instructed in various gesticulations. They are supposed to attain great longevity. The female is particularly attentive to her young, and scarcely ever produces more than two at a birth, which, after being suckled a fortnight on the shore, where they are always born, are conducted to the water, and taught by their dam the means of defence and subsistence; and when they are fatigued by their excursions, are relieved by being taken on her back. They distinguish her voice, and attend at her call. The flesh of seals is sometimes eaten, but they are almost always destroyed for their oil and skins. The latter are manufactured into very valuable leather, and the former are serviceable in a vast variety of manufactures. The ursine seal grows to the length of eight feet, and to the weight of a hundred pounds. These are found in vast abundance in the islands between America and Kamtschatka, from June till September, when they return to the Asiatic or American shores. They are extremely strong, surviving wounds and lacerations which almost instantly destroy life in other animals, for days, and even weeks. They may be observed not merely by hundreds, but by thousands, on the shore; each male surrounded by his females, from eight to fifty, and his offspring amounting frequently to more than that number. Each family is preserved separate from every other. The ursine seals are extremely fat and indolent, and remain with little exercise, or even motion, for months together upon the shore. This harmless seal has been frequently mistaken for the fabled mermaid.

PHŒNICOPTEROS, the *Flamingo*, in Natural History, a genus of birds of the order grallæ. The common flamingo, the only species noticed by Latham, is nearly of the size of a goose, and upwards of four feet long. When mature in plumage, these birds are all over of the most deep and beautiful scarlet; but this muturity they never acquire till their third year. They are found in France, Spain, and Italy, in Syria, and in Persia, but more frequently than any where else, on the coast of Africa, downwards to the Cape. They build their nest of mud, in the shape of a hillock, and in a cavity on the top of it the female deposits two white eggs, on which she sits, having her legs stretched out, one each side of the hillock.

PHŒNIX, the great palm or date tree, a genus of plants of the order palmæ. There is only one species, *viz.* the dactylifera, or common date tree, a native of Africa and the eastern countries, where it grows to 50, 60, and 100 feet high.

PHŒNIX, in Astronomy. Our astronomers have probably given this constellation the name of Phœnix, after the example of the Arabians, who were acquainted with it under the appellation of the Griffin, or Eagle, from the most remote antiquity. These people adored an idol under the form of an eagle, and according to Hyde, (*Hist. Vet. Pers.*) this eagle was one of the celestial signs. The brilliant star called *Achernar*, beside this asterism, is distinctly visible during the summer months in Arabia, whence the Phœnix was fabled to come. Erasmus says the Phœnix was the symbol of the year, or of the annual revolution; and to the Egyptians this constellation rose, as it were, from Arabia, shortly before the commencement of their sacred year.

PHONICS, the same as ACOUSTICS.

PHOSPHATS, salts formed by the phosphoric acid, with the alkalies, earths, and metallic oxides. The phosphats at present known amount to twelve; two of which are triple salts.

PHOSPHITES, salts formed with the phosphorous acid united to the earths, alkalies, and metallic oxides.

PHOSPHORIC ACID. The base of this acid, or the acid itself, abounds in the mineral, vegetable, and animal kingdoms. In the mineral kingdom it is found in combination with lead, in the green lead ore; with iron, in the bog ores which afford cold-short iron; and more especially with calcareous earth in several kinds of stone. Whole mountains in the province of Estremadura, in Spain, are composed of this combination of phosphoric acid and lime. In the animal kingdom it is found in almost every part of the bodies of animals which are not considerably volatile. There is not, in all probability, any part of these organized beings which is free from it. It has been obtained from blood, flesh, both of land and water animals; from cheese; and it exists in large quantities in bones, combined in calcareous earth. Urine contains it not only in a disengaged state, but also combined with ammonia.

PHOSPHOROUS ACID is prepared by exposing phosphorus during some weeks to the ordinary temperature of the atmosphere. Even in winter the phosphorus undergoes a slow combustion, and is gradually changed into a liquid acid. For this purpose it is usual to put small pieces of phosphorus on the inclined side of a glass funnel, through which the liquor which is formed drops into the bottle placed to receive it. From an ounce of phosphorus about three ounces of acid liquid may be thus prepared.

PHOSPHORUS, a substance which shines by its own light. The discovery of this singular substance was accidentally made in 1677, by an alchemist of Hamburgh, named Brandt, when he was engaged in searching for the philosopher's stone. Kunkel, another chemist, who had seen the new product, associated himself with one of his friends, named Krafft, to purchase the secret of its preparation; but the latter deceiving his friend, made the purchase for himself, and refused to communicate it. Kunkel, who at this time knew nothing further of its preparation, than that it was obtained by certain processes from urine, undertook the task, and succeeded. It is on this account that the substance long went under the name of Kunkel's phosphorus. Mr. Boyle is also considered as one of the discoverers of phosphorus. He communicated the secret of the process for preparing it, to the Royal Society of London, in 1680. It is asserted indeed by Krafft, that he discovered the secret to Mr. Boyle, having, in the year 1678, carried a small piece of it to London, to shew it to the royal family; but there is little probability that such a man as Mr. Boyle would claim the discovery as his own, and communicate it to the Royal Society, if this had been the case. Mr. Boyle communicated the process to Godfrey Hankwitz, an apothecary of London, who for many years supplied Europe with phosphorus, and hence it went under the name of English phosphorus. In the year 1774, the Swedish chemists, Gahn and Scheele, made the important discovery, that phosphorus is contained in the bones of animals, and they improved the processes for procuring it. The most convenient process for obtaining phosphorus, seems to be that recommended by Fourcroy and Vauquelin, which we shall transcribe. Take a quantity of burnt bones, and reduce them to powder. Put 100 parts of this powder into a porcelain or stone-ware bason, and dilute it with four times its weight of water. Forty parts of sulphuric acid are then to be added in small portions, taking care to stir the mixture after the addition of every portion. A violent effervescence takes place, and a great quantity of air is disengaged. Let the mixture remain for twenty-four hours, stirring it occasionally to expose every part of the powder to the action of the acid. The burnt bones consists of the phosphoric acid and lime, but the sulphuric acid has a greater affinity for the lime than the phosphoric acid. The action of the sulphuric acid uniting with the lime, and the separation of the phosphoric acid, occasion the effervescence. The sulphuric acid and the lime combine together, being insoluble, and fall to the bottom. Pour the whole mixture on a cloth filter, so that the liquid part, which is to be received in a porcelain vessel, may pass through. A white powder, which is the insoluble sulphate of lime, remains on the filter. After this has been repeatedly washed with water, it may be thrown away; but the water is to be added to that part of the liquid which passed through the filter. Take a solution of sugar of lead in water, and pour it gradually into the liquid in the porcelain bason. A white powder falls to the bottom, and the sugar of lead must be added so long as any precipitation takes place. The whole is again to be poured upon a filter, and the white powder which remains, is to be well washed and dried. The dried powder is then to be mixed with one-sixth of its weight of charcoal powder. Put this mixture into an earthenware retort, and place it in a sand bath, with the beak plunged into a vessel of water. Apply heat, and let it be gradually increased till the retort becomes red-hot. As the heat increases, air-bubbles rush in abundance through the beak of the retort, some of which are inflamed when they come in contact with the air at the surface of the water. A substance at last drops out similar to melted wax, which congeals under the water. This is phosphorus. To have it quite pure, melt it in warm water, and strain it several times through a piece of shamoy leather, under the surface of the water. To mould it into sticks, take a glass funnel with a long tube, which must be stopped with a cork. Fill it with water, and put the phosphorus into it. Immerse the funnel in boiling water, and when the phosphorus is melted, and flows into the tube of the funnel, then plunge it into cold water, and when the phosphorus has become solid remove the cork, and push the phosphorus from the mould with a piece of wood. Thus prepared, it must be preserved in close vessels containing pure water. When phosphorus is perfectly pure it is semi-transparent, and has the consistence of wax. It is so soft that it may be cut with a knife. Its specific gravity is from 1·77 to 2·03. It has an acid and disagreeable taste, and a peculiar smell, somewhat resembling garlic. When a stick of phosphorus is broken, it exhibits some appearance of crystallization. The crystals are needle-shaped, or long octahedrons; but to obtain them in their most perfect state, the surface of the phosphorus, just when it becomes solid, should be pierced, that the internal liquid phosphorus may flow out, and leave a cavity for their formation. When the phosphorus is exposed to the light, it becomes of a reddish colour, which appears to be an incipient combustion. It is, therefore, necessary to preserve it in a dark place. At the temperature of 90° it becomes liquid, and if air be entirely excluded, it evaporates at 219°, and boils at 554°. At the temperature of 43° or 44° it gives out a white smoke, and is luminous in the dark: this is a slow combustion of the phosphorus, which becomes more rapid as the temperature is raised. When phosphorus is heated to the temperature of 148° it takes fire, burns with a bright flame, and sends out a great quantity of white smoke. Phosphorus enters into combination with oxygen, azote, hydrogen, and carbon. Phosphorus is soluble in oils, and when thus dissolved, forms what has been called liquid phosphorus, which may be rubbed on the face and hands without injury. It dissolves too in ether, and a very beautiful experiment consists in pouring this phosphoric ether in small portions, and in a dark place, on the surface of hot water. The phosphoric matches consists of phosphorus extremely dry, minutely divided, and perhaps a little oxygenized. The simplest mode of making them, is to put a little phosphorus, dried by blotting paper, into a small phial; heat the phial, and when the phosphorus is melted turn it round, so that the phosphorus may adhere to the sides. Cork the phial closely, and it is prepared. On putting a common sulphur match into a bottle, and stirring it about, the phosphorus will adhere to the match, and will take fire when brought out into the air.

PHOSPHURETS, substances formed by an union of the alkalies, earths, and metallic oxides, with phosphorus. Thus we have phosphuret of lime, &c.

PHOTOMETER, an instrument intended to indicate the different quantities of light, as in a cloudy or bright day, or between bodies illuminated in different degrees. In Leslie's photometer, the essential part is a glass tube like a reversed syphon, whose two branches should be equal in height, and terminated by balls of equal diameter; one of the balls is of black enamel, and the other of common glass, into which is put some liquid. The motion of the liquor, which is sulphuric acid tinged red with carmine, is measured by means of a graduation, the zero is situated towards the top of the branch that is terminated by the enamelled ball. The use of this instrument is founded upon the principle, that when the light is absorbed by a body, it produces a heat proportional to the quantity of absorption. When the instrument is exposed to the solar rays, those rays that are absorbed by the dark colour heat the interior air, which causes the liquor to descend at first with rapidity in the corresponding branch. But as a part of the heat which had introduced itself by means of the absorption is dissipated by the radiation, and as the difference between the quantity of heat lost and that of the heat acquired goes on diminishing, there will be a point where, these two quantities having become equal, the instrument will be stationary, and the intensity of the incident light is then estimated by the number of degrees which the liquor has run over. The author of this ingenious instrument has pointed out its advantages in determining the progressive augmentation undergone by the intensity of the light, and the gradation in a contrary sense which succeeds to that progress, both from the beginning of the day to its end, and from the winter solstice to the end of the succeeding autumn. With the help of such an instrument, one might also compare the action of the rays of light in different countries, of which some dart with sufficient constancy from a fine and serene sky, while others seem to be covered with a veil which dims and obscures their lustre.

PHYGETHLON, in Surgery, a broad but not much elevated tumour, of the same nature with the bubo.

**PHYLACTERY**, in Antiquity, a charm or amulet, which being worn, was supposed to preserve people from certain evils, diseases, and dangers.

**PHYSETER**, *Cachalot*, a genus of fishes of the order cete. Physeter macrocephalus, blunt-headed cachalot. This whale, which is one of the largest species, is scarcely inferior in size to the great mysticete, often measuring sixty feet or more in length. The head is of an enormous size, constituting more than a third of the whole animal; the mouth wide, the upper lip rounded, thick or high, and much broader than the lower; which is of a somewhat sharpish form, fitting in a manner into a longitudinal bed or groove in the upper. The teeth, at least the visible ones, are situated only in the lower jaw, and when the mouth is closed, are received into so many corresponding holes or cavities in the upper; they are pretty numerous, rather blunt, and of a somewhat conic form, with a very slight bend or inclination inwards. The front of the head is very abrupt, descending perpendicularly downwards; and on its top, which has been improperly termed the neck by some authors, is an elevation or angular prominence containing the spiracle, which appears externally simple, but is double within. The head is distinguished or separated from the body by a transverse furrow or wrinkle. The eyes are small and black; and the ears or auditory passages extremely small. About the middle of the back is a kind of spurious fin, or dorsal tubercle, of a callous nature, not moveable, or somewhat abrupt or cut off behind. The tongue is of the shape of the lower jaw, clay-coloured externally, and of a dull red within. The throat is but small in proportion to the animal. The body is cylindrical beyond the pectoral fins, growing narrower towards the tail. The colour of the whole animal is black, but when advanced in age grows whitish beneath. It swims swiftly, and is said to be a violent enemy to the squalus carcharias, or white shark, which is sometimes driven ashore in its endeavours to escape, and, according to Fabricius, will not venture to approach its enemy, even when dead, though fond of preying on other dead whales. It is in a vast cavity within the upper part of the head of this whale, that the substance called spermaceti is found, which, while fresh and in its natural receptacle, is nearly fluid; but when exposed to the air, concretes into opake masses: this substance being so universally known, it becomes unnecessary to describe it farther. A more curious and valuable production, the origin of which has long eluded the investigation of naturalists, is obtained from this animal, *viz.* the celebrated perfume called ambergris, which is found in large masses in the intestines, being in reality no other than the fæces.

**PHYSICAL**, any thing relating to physics.

**PHYSICIANS.** No person within London, nor within seven miles of the same, shall exercise as a physician or surgeon, except he is examined and approved by the bishop of London, or by the dean of St. Paul's, calling to them four doctors of physic, and for surgery, other expert persons in that faculty, of them that have been approved, upon the pain of forfeiture for every month £5, one half to the king and the other half to any that will sue. One that has taken his degree of doctor of physic in either of the universities, may not practise in London, and within seven miles of the same, without license from the college of physicians.

**PHYSICO MATHEMATICS**, is the same as mixed mathematics, being those branches of this science which investigates the laws and actions of bodies, and their combinations, by means of certain data drawn from observation and experiment.

**PHYSICS**, is a term denoting the same as experimental or natural philosophy; being the doctrine of natural bodies, their phenomena, causes, and effects, with their various affections, motions, and operations.

*Experimental* PHYSICS, is that which inquires into the nature and reason of things by experiments, as in hydrostatics, pneumatics, optics, chemistry, &c.

*Mechanical* PHYSICS, explains the appearances of nature from the matter, motion, structure, and figures of bodies, and their several parts, according to the established laws of nature.

**PHYSIOGNOMY**, is the peculiar combination of features, which designates the feelings and dispositions of the mind. That every individual of the human race possesses a set of distinctive marks, in the form of the head and the outlines of the countenance, is visible to the most inattentive observer: and it is well known, that those marks insensibly lead us to form conclusions as to the nature and inclinations of persons to whom we are introduced for the first time, which may sometimes be correct, but are frequently erroneous. Admitting this fact, as to mankind in general, it will be proper to observe, that however the study of physiognomy may be commended and recommended, it should be exercised with great discretion and judgment, or very fatal, or, at least very disagreeable, consequences may be the result; for it must be remembered, that numerous causes exist to derange and discompose the human frame during infancy, and even before the birth, which may impress a character or expression on the features, descriptive of evil passions that never existed in the mind of the unfortunate person so situated; for instance, it would be inhuman to judge of the soul of one who has had the vertebræ of his back doubled, from the expression of his face, which is uniformly that of peevishness and confirmed ill-nature; nor would it be just to think a man capable of every kind of wickedness, whose head and face bear the marks of malice, through a deformity existing perhaps before his birth. Were the bones incompressible from the instant they are formed, and the muscles incapable of being moulded to their shape, in short, did mankind receive a decided and unalterable outline from the Creator, we should then make correct conclusions from the beauty or irregularity of the face. The aid of Lavater is not necessary to inform us that there exists a national physiognomy, by which a stranger in any given country may be known by those who are possessed of previous observation, to be a Spaniard, a German, or a Frenchman, and which impels even the very vulgar to exclaim, "He is a foreigner," though they cannot appropriate him to his country. After all, it will be admitted that this science, if such it can fairly be denominated, must be precarious, and, in some respects, delusive. It cannot, however, be doubted, that there is an apparent correspondence between the face and the mind: the features and lineaments of the one are directed by the motions and affections of the other; there is, perhaps, even a peculiar arrangement of the members of the face, and a peculiar disposition of the countenance to each particular affection of the mind.

**PHYSIOLOGY**, is the science which treats of the powers that actuate the component parts of living animal bodies, and of the functions which those bodies execute. The life of a body is better known by observation than can be described by words. If it be possible to give a sort of definition of it, the following is as true as it will admit of: that life tends by an universal sympathy, or assimilating action, to produce another body similar to itself. This sympathy seems to exist between the circulating and the nervous systems; as for instance, in order that sensibility may be acute (or secretion performed) a very extensive circulation, and an equally diffuse distribution of nerves, is necessary. We may conveniently consider the nervous system as consisting of the brain, spinal cord, and nerves; and the vascular system as consisting of arteries, veins, absorbents and exhalants, universal; while the others, as the respiratory, nutritive, generative, and those of waste, may be called partial systems. The nervous system especially tends, from its supplying us with sensibility and heat, to oppose the processes consequent to mere matter. The brain is the organ of the mind. The cerebral lobes are the seat of sensation and volition. The cerebellum regulates the actions of running, walking, standing, flying, &c. The spinal cord, with the medulla oblongata, corpora quadrigemina, and nerves, are the seat of those impressions which give rise to muscular contractions; and the spinal cord combines or generalizes the contractions, so as to produce motion of the joints. The spinal cord seems to be formed previous to the development of the brain, and is so necessary to life that few animals want it, and is perfect in proportion as their organization is perfect. The human species is endowed with three sorts of nerves, *viz.* 1. Those of the different external senses. 2. Those requisite for motion. 3. Those necessary to the supply and waste of the machine. The contraction of both sides of the heart takes place at the same time. Arteries are conical tubes, whose base originates from the heart; they have a tonic power depending on their degree of life, the vessels are constantly full of blood, so that the quantity sent out from the ventricle merely acts as a jet upon the mass already in the arteries, and gives to the containing vessels a sort of motion. The blood in the veins is urged on partly by the power behind, and also by a species of suction exerted from the right side of the heart. The general circulation may be thus described: all the blood, except that of the lungs, is brought to the right auricle, and compressed into the right ventricle to be circulated through the lungs, whence it is returned by the pulmonary veins to the left auricle, thence sent into the left ventricle, to be distributed through the whole body, except the lungs. The blood, in passing through the lungs loses that dark colour acquired from its tardy transmission by the veins, the change is most probably decarbonization, and is necessary to the healthy action of the heart. Some peculiarities may be noticed relating to the circulation; the connexion of the circulation in the genital organs and mamma. That of the liver which is entirely venous, and consisting of the blood which had been distributed to the organs of digestion, collected into a large vein, (vena portæ,) which again ramifies itself like an artery through the substance of the liver. Again the circulation through the brain is by arteries terminating in sinuses, and upon the principle of the syphon. The absorbents, as constituting part of the vascular system, may be arranged into two classes; those which absorb a fluid necessary to the nutrition of the body, and those which admit of grosser substances. The first are those which arise from the stomach and intestinal canal, and terminate in the thoracic duct to enter the venous system by the subclavians. The others are spread over the whole body, and enter the veins in their neighbourhood: each of those sets has a sort of elective power.

*Of the partial Systems:*—The external senses, sight, hearing, taste, smell, and touch, depend upon a proportional increase of the universal systems. Respiration is essential to the maintenance of the circulation, the lungs are full of cells into which there is an exhalation from the arteries ramified on them, it is here where the blood becomes decarbonated, or, as some would have it, oxygenated. Absorption is exceedingly quick in them. The action of the lungs may be compared to the action of two bladders within a bellows, and fitted by means of a common communication to the tube of the bellows, no air being admitted by the tube or usual hole into the cavity of the bellows external to the bladder. Another important use of the lungs is by its forcible emission of air through the glottis, producing voice, which, modified by the tongue, palate, teeth, and lips, furnishes us with the power of articulation. We may now consider the circle of organs engaged in nutrition or supply and waste. There is a sympathy extending along the whole range of these organs, *viz.* the mouth, gullet, stomach, and spleen, intestines, and liver, and pancreas; so that if any thing should be conveyed into the stomach, even without the action of the mouth, a secretion of saliva would take place, &c. Alimentation commences with the mastication of the food, during which action it is mixed with saliva, it is then swallowed, mixed with the gastric juice in the stomach, converted into a mass called chyme, thence passes into the bowels; coming in contact with the biliary and pancreatic secretions, it is separated into two substances, one named chyle, which is to be absorbed for the nutrition of the frame, the other to be evacuated. Hunger arises from the action of the gastric juice on the coats of the stomach.—The fœtus is not part of the body of the mother, but derives its own nourishment as a distinct animal by its own mechanism. Its mechanism serves only for its nourishment, being an imperfect animal, and not enjoying any of the external senses. The circulation of the blood in the fœtus is different. The blood from the umbilical vein partly passes through the liver, partly by the ductus venosus, into the vena cava, thence to the right auricle, the right auricle throws it partly into the right ventricle, but the greater part through the foramen ovale into the left auricle. The portion sent to the right ventricle is transmitted through the pulmonary artery to the lungs in part, and also by the canalis arteriosus into the aorta. The blood which the pulmonary veins bring into the left auricle passes with that through the foramen ovale into the left ventricle, to be transmitted through the aorta to the whole system. The urinary system serves to throw off the urea from the circulation, consequently a mere organ of waste.

**PHYTOLOGY**, a discourse concerning the kinds and virtues of plants.

**PHYTOTAMA**, a genus of birds of the order passeres. There is only a single species, *viz.* P. rara, that inhabits Chili.

**PIASTER**, a Spanish coin of the value of 4*s.* 6*d.* sterling.

**PIAZZA**, in Architecture, is a portico, or covered walk supported by arches; and all walks with porticos around them, are piazzas, as the fine walks around the Royal Exchange, London, one of the most classical and yet national monuments to be found in Europe.

**PICÆ**, the second order of birds, according to the Linnæan system. The male feeds the female while she is sitting. They live in pairs. Of this order there are twenty-six genera.

**PICARD, John**, a celebrated French mathematician and astronomer of the 17th century, was the first who applied the telescope to astronomical instruments, and commenced the publication of the "Connaissance des Tems," which he calculated from 1679 to 1683. He also first measured the length of a degree of the meridian in France, and gave a map of that country. The time of his birth is not known, but he died in 1682 or 1683. Picard was author of several works on Levelling, Dialling, Dioptrics, Discharge and Mensuration of Fluids, Astronomy, &c. the whole of which are given in the 6th and 7th volumes of the Memoirs of the Academy of Sciences.

**PICKETS**, in Fortification, sharp stakes about three feet long, sometimes shod with iron, used in laying out ground. But when used for pinning the fascines of a battery, they are from three to five feet long. In the Artillery, pickets five feet long, are used to pin the park lines; in the camp, they are used about eight inches long, to fix the tent cords; or five feet long in the cavalry camp, to fasten the horses.

**PICRANIA AMARA**, a bitter wood of Jamaica, belonging to the pentandria class of plants. The tree is tall, its timber beautiful, but every part of it is intensely bitter; and in cabinet work it is invaluable, as no insect will live near it. How excellent then for beds! This tree has a great affinity to the quassia amara of Linnæus, in lieu of which, it is used as an antiseptic in putrid fevers.

**PICQUET**, a celebrated game at cards played between two persons, with only thirty-two cards; all the twos, threes, fours, fives, and sixes, being set aside.

**PICUS**, the *Wood-pecker*, in Natural History, a genus of birds of the order Picæ. These birds live principally upon insects, to obtain which they climb trees, and are perpetually in search of those crevices in which their food is lodged: there are fifty species. The greatest black wood-pecker, abounds in Germany, and builds in ash and poplar trees, which they are said to excavate speedily, so as to expose them to be blown down by winds which would not otherwise have affected them; under the hole made by these birds may be often found several pecks of dust and pieces of wood. They are of the size of a jackdaw. The green wood-pecker, is the largest species in Great Britain, and is thirteen inches long. These birds are more frequently seen on the ground than the other species, particularly where ant-hills abound, the population of which they almost extirpate by their incessant efforts. The witwall, is nine inches long, and strikes with far greater comparative force against the trees than any of the tribe.

**PIEPOUDRE**, *Court of*, the lowest, and at the same time the most expeditious, court of justice known to the law of England. It is called piepoudre (curia pedis pulverisati) from the dusty feet of the suitors. But the etymology given us by a learned modern writer is much more ingenious and satisfactory; it being derived, according to him, from pied puldreaux, "a pedlar," in old French, and therefore, signifying the court of such petty chapmen as resort to fairs or markets. It is a court of record, incident to every fair and market; of which the steward of him who owns or holds the toll of the market is the judge. It was instituted to administer justice for all commercial injuries done in that very fair or market, and not in any preceding one; so that the injury must be done, complained of, heard, and determined, within the compass of one and the same day, unless the fair continues longer.

# [illegible] Suspension Bridges

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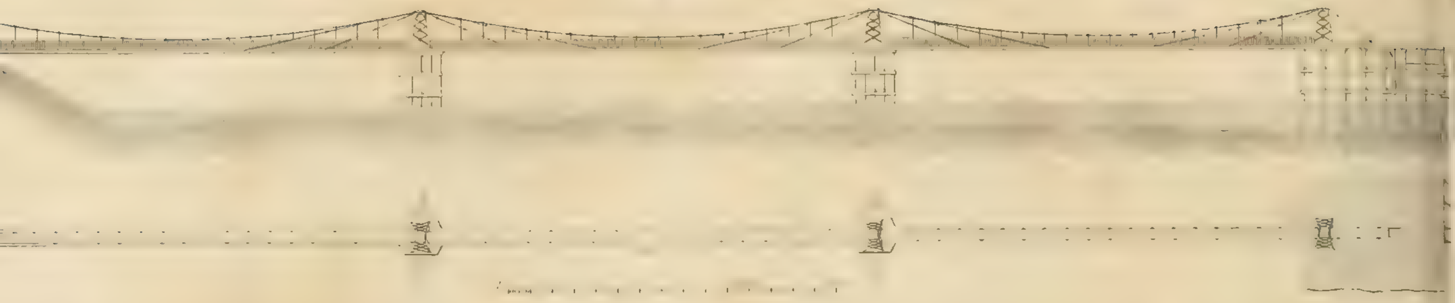

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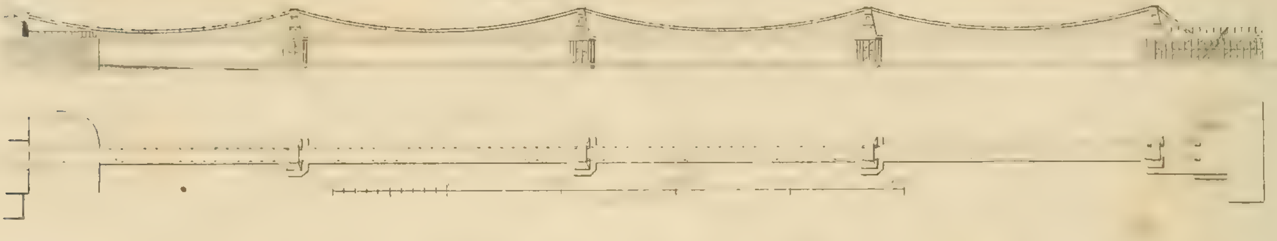

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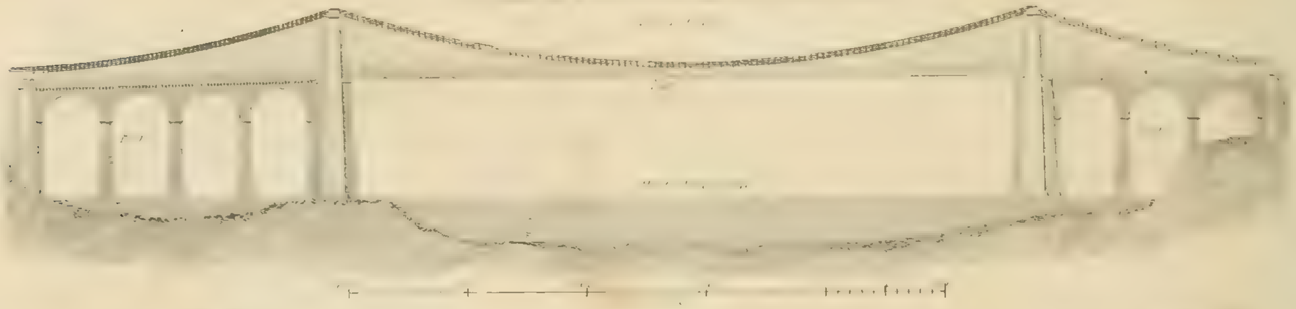

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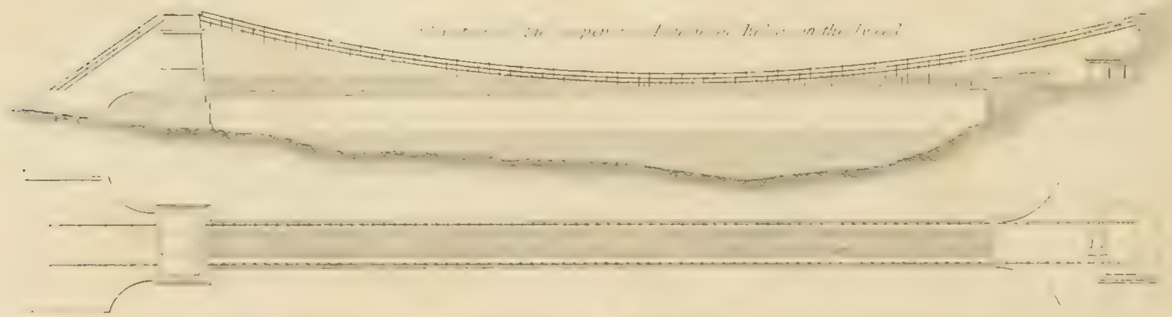

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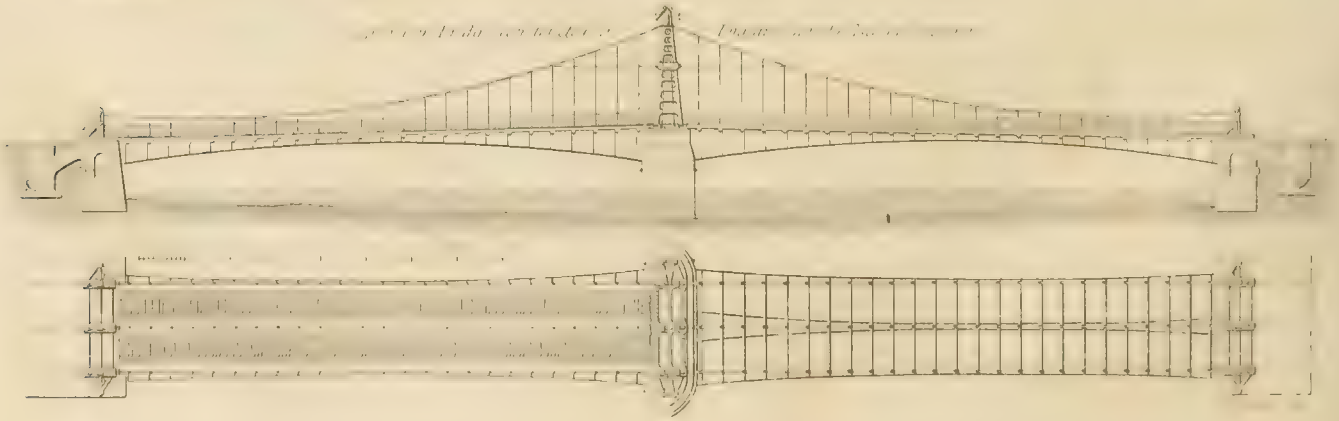

# Pile Engines &c

**Vauloue's Pile Engine.**

Fig 2

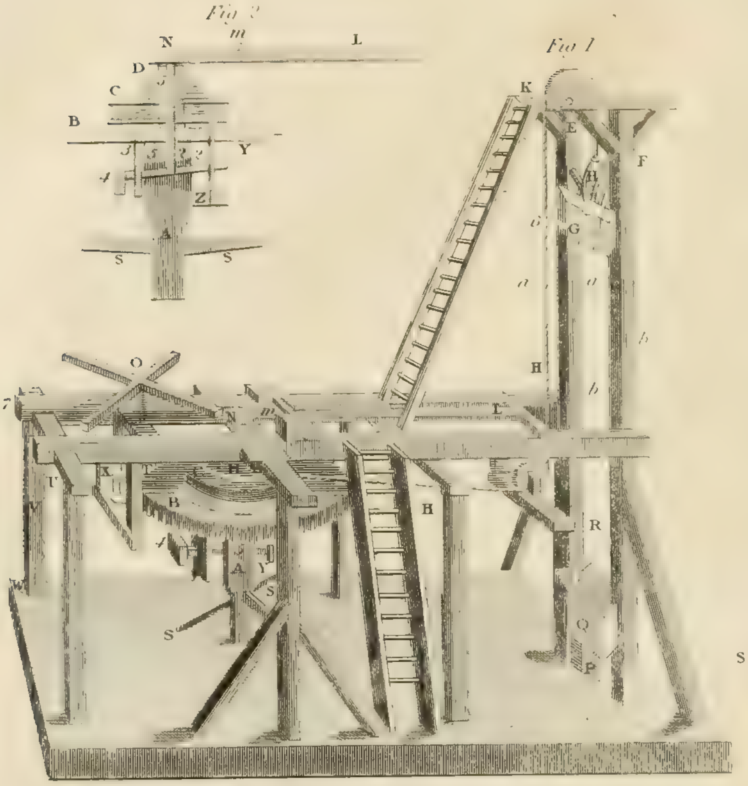

Fig 1

**Bunce's Pile Engine**

Fig 4

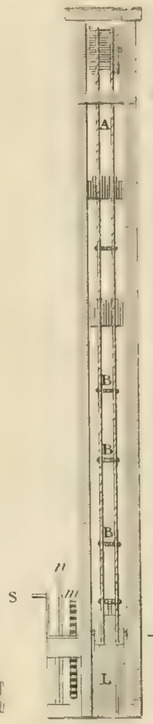

Fig 3

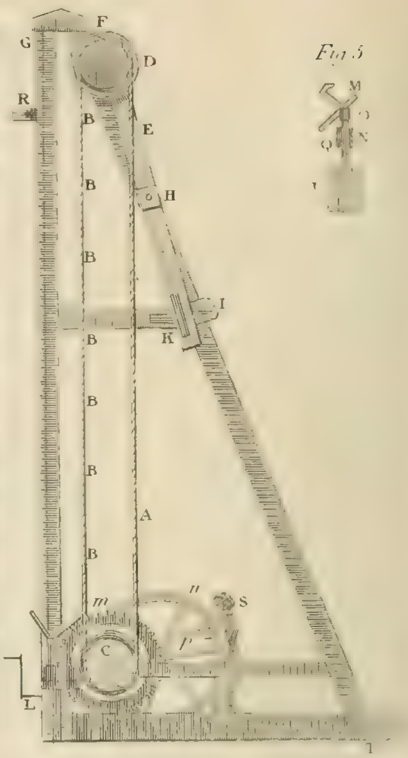

Fig 5

# Machine for boring Wooden Pipes.

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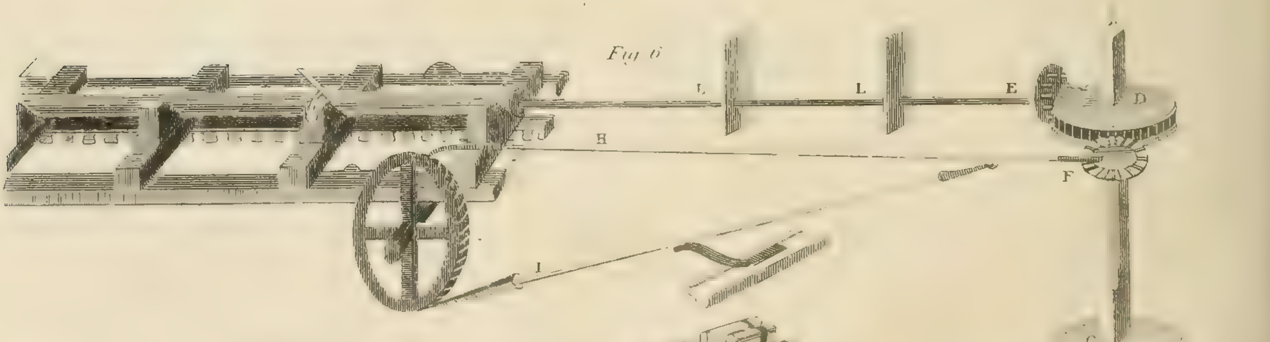
Fig 6



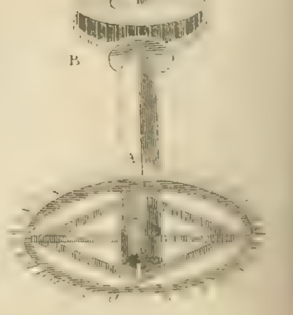
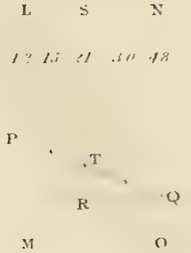


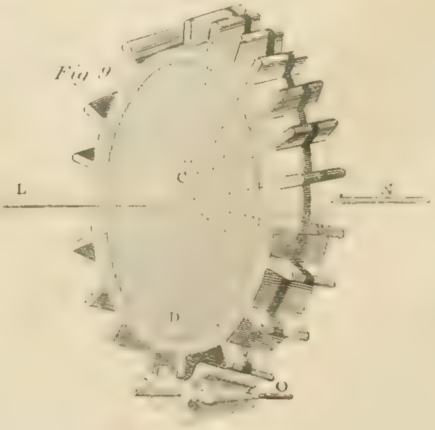
Fig.7



Planet Wheels p.87

Fig 8

Fig 9



**PIER**, a strong mound or fence projecting into the sea, to break off the violence of the waves from the entrance of a harbour.

**PIERS**, in the theory of Bridges, are the walls built to support the arches, and from which they spring as bases.

**Piers** and *Suspension Bridges.* (See Plate.) –In nothing perhaps do the French shew their enmity of the British, more than in depreciating our inventions, and in appropriating to themselves, or assigning to others, plans, discoveries, inventions, and improvements, exclusively British. We are led to this introductory remark by an assertion of Dupin, in his Treatise on the Commercial Power of Great Britain, in which he says, that from North America the noble application of iron to chain bridges was soon transferred to Europe, vol. i. p. 370. Again the French baron tells us, p. 374, "The Americans commenced their constructions about the end of the last century," *i. e.* about thirty years ago, reckoning from 1826, the period when we published letter P of our Dictionary.

Now it is in print, in opposition to Dupin's assertion, that for a long time the Europeans have had an idea of suspension bridges, as may be seen in the bridges described in the work that Faustus Varentius published in 1625; and "80 years ago," (says Dupin very unguardedly for his admiration of the Americans) "the English threw over the Tees at Winch, near Durham, a bridge of iron wire, which served for foot passengers. The Chinese and Peruvians seem to have been the first nations that used suspension bridges; but those of the latter kept the catenarian bend, and the roads they afforded were very inconvenient in their passage.

To Capt. Brown, of the British navy, we are indebted for the idea and execution of suspension and chain piers, of considerable length, in ports and on shores, where ships are unable to approach the beach for a great distance, even at high water. For the embarkation of troops, cavalry horses, baggage, and munitions of war, these suspension piers are very useful. In 1821, Capt. Brown exhibited the first model of these new constructions at Leith. In order to reach, from the shore, the place in the Forth where ships could keep afloat without danger at high or low water, and in very bad weather, it was necessary to advance 233 yards into the sea, reckoning the distance from the high-water mark on shore. To fill up this long space, three arches of suspension chains were formed, each having 249 feet in span; thus the pier is held by four supports only,—one on shore, and three upon piles in the middle of the sea. To describe this work systematically, we will mention, in succession, the piers, the abutments, the suspension chains, and the flooring or road way.

*Piers and Abutments.*—The principal pier is that which is at the head of the chain pier; it is formed by six rows of piles, having the same direction with the suspension chains; cross timbers consolidate the part above water, the summit of which leaves a flooring or platform of wood. This platform has a hatchway leading to a flight of stairs, descending as low as the level of low water. A plank thrown across, from the last step to the steam-boats, or other vessels, near the landing pier, enables people either to land or to embark. The two intermediate piers, between the shore and the landing place, are formed with piles, so planted as to represent a lozenge; they are covered with a platform, upon which rest the iron bench which bears the suspension chains. To serve as a common support to these chains and their wards, a stone pillar has been built upon the shore, having twenty feet in height upon a square base, six feet on each side; from the top of this pillar or support, the chains, or land-wards, with an inclination of about forty-five degrees, reach the ground, in which they penetrate to a depth of about ten feet, where they are fixed by means of cast-iron ballast plates, in a manner similar to those used by Capt. Brown in the suspension bridge thrown by him across the Tweed. On the side of the landing platform, each of the chains has likewise an inclination of forty-five degrees, and is attached to one of the piles supporting it. Shores, placed obliquely, serve the purpose of resisting the great strains experienced by the chains. The benches used to support the chains, whether seen longitudinally or transversely, are made of iron, open, but combining, nevertheless, lightness with solidity. At the summit they are attached to two oblique suspending rods, supporting both the landing pier and the flooring.

*Suspension Chains, &c.*—The suspension chains, as to their form, and the joining together of the parts composing them, resemble those used in the construction of the Union Bridge upon the Tweed; they differ in one point only—the links, which are close to the points of support, having to bear a greater weight, are made thicker than those placed in the middle of the chains. The suspending rods are round, except the lower end, where they fork, in order to receive the flat iron, or lath, which runs along the whole length of the chain pier, and upon which the end of the beams supporting the flooring are resting; the planks forming this flooring are two inches thick. On each side of the pier is a cornice, which covers over the ends of the beams; the parapet is made of iron, four feet high, and firmly joined with the suspending rods.

In order to try the power of this chain pier, Capt. Brown, as soon as it was terminated, loaded it with the immense weight of 210 tons, which he suffered to remain for a great length of time, notwithstanding the casual burden occasioned by passengers, and the shaking produced by their movement. No part of the erection has been observed to suffer from the movements, or by the great strains produced on the chains by so great a burden. Such a fact affords the most satisfactory proof as to the solidity of this system of chain landing piers.

At Brighton, a handsome chain pier is now erected also, but on a scale much more extensive than the Leith pier; it being composed of three inverted arches, having each 230 feet of span; its width is about 12 or 14 feet.

**PIG of Ballast**, a large mass of cast iron or lead, used for ballast.

**PIGEONS.** Every person who shall shoot at, kill, or destroy a pigeon, may be committed to the common jail for three months, by two justices of the peace, or pay 20*s.* to the poor. 1 Jac. 1. c. 27.

**PIKE**, an offensive weapon, consisting of a shaft of wood, twelve or fourteen feet long, headed with a flat-pointed steel, called the spear.

**Pike**, or *Jack*, a fish; see Esox, p. 276.

**PILASTER.** *See* Architecture.

**PILE**, in Artillery, denotes a collection or heap of balls or shells, piled up in a pyramidal form, the base being some regular figure, as an equilateral triangle, square, or rectangle, and the whole pile a series of such figures, the side of each successive row diminishing by one from the bottom upwards. Therefore the whole number of balls is equal to the sum of a series of triangular numbers, squares, or rectangles, according to the figure of the pile, by experiment. The algebraic formulæ are difficult to remember upon an emergency; and therefore the following general rule, for this purpose, which is not commonly known, is deserving the notice of artillery officers.

*Rule.*—In every pile there may be found three parallel lines, the sum of which multiplied by the number of balls in the triangular face of the pile, and divided by 3, is the number of balls. In the rectangular pile, the three parallel lines are the two bottom rows in length, and the upper ridge of the pile; and the face the triangular end. In the square pile, any two opposite sides of the square base, and the upper ball, are three parallel lines. And in the triangle pile, one side of the bottom row, the opposite extreme ball, and the upper ball, are the three parallel sides; the face in both these cases being any of the equal slant sides of the pile.

**Pile**, in Coinage, denotes a kind of puncheon, which in the old way of coining with the hammer, contained the arms, or other figure and inscription, to be struck on the coin.

**Piles**, in Building, are large stakes or beams sharpened at the end, and shod with iron, to be driven into the ground for a foundation to build upon in marshy places.

**Pile** *Engine*, is an engine used for driving piles.

*Vauloue's Pile Engine.* (See Plate.)—The horses which work this engine are yoked at S S, and by moving the wheel B and drum C, which are locked together, raise the follower G H, (carrying the ram Q by the handle R), by means of the rope H H, which coils round the drum. When the follower G reaches the top of the frame, the upper legs of the tongs H are closed by pressing against the adjacent beams: and their lower legs are opened, so that they drop the ram Q, which falls and strikes the pile. When G is at the top of the frame, the crooked handle 6, of the follower G, presses against the cords *a*, *a*, which raise the end of the lever L (see fig 2.) round *m* as a centre, and by depressing the extremity N, and consequently the bar S, S, unlock the drum C and the wheel B, so that the follower G falls by its weight and seizes the ram R. As soon as the follower drops, the horses would tumble down, having no resistance to overcome, were not this prevented by the fly O, which is moved by the wheel B and trundle X, and opposes a sufficient resistance to the horses till the follower again seizes the ram. When the follower falls, the weight L (fig. 2.) pushes up the bolt Y into the drum C, and locks the wheel and the drum; and the same operation is afterwards repeated.

*Bunce's Pile Engine.* See Plate.—A side view of this engine is shewn in fig. 3, 4. It consists of two endless ropes or chains A, connected by cross pieces of iron B, B, &c. (fig. 4,) which pass round the wheel C, the cross pieces falling into corresponding cross grooves, cut in the periphery of the wheel. When the man at S, therefore, drives the wheel *m* by means of the pinion *p*, he moves also the wheel C fixed on the axis of *m*, and makes the double ropes revolve upon the wheels, C, D. The wheel D is fixed at the end of a lever D H K, whose centre of motion is H, a fixed point in the beam F T. Now when the ram L (fig. 3, 5.) is fixed to one of the cross pieces B by the hook M, the weight of the ram acting by the rope, moves the lever D K round H, and brings the wheel D to G, so that by turning the winch, the ram L (fig. 3.) is raised in the vertical line L R G. But when it reaches R, the projecting piece R disengages the ram from the cross piece B, by striking the bar Q; and as the weight is removed from the extremity D of the lever, the counterpoise I brings it back from G to its old position at F, and the ram falls without interfering with the chain. When the hook is descending, it is prevented from catching the rope by means of the piece of wood N suspended from the hook M at O; for being specifically lighter than the iron weight L, and moving with less velocity, it does not come in contact with L till the ram is stopped at the end of its path. When N, therefore, falls upon L, it depresses the extremity M of the hook, and therefore brings the hoop over one of the cross pieces B, by which the ram is again raised.

The pile engine offers a remarkable confirmation of the doctrine of percussion, proving that, physically speaking, we may balance any percussive force by an equivalent one of mere pressure, or even we may make the latter greater so as to overcome the former. It has, for instance, been found, that in driving piles in a uniform sandy oil of the same density to 47 feet, the piles could not be driven more than 15 feet by any percussive blow that could be communicated by the engine; that is, the friction and resistance of the soil which may be considered as a pressive force, was greater than any percussion force that could be employed by the pile engine, although the rammers made use of were extremely great. And hence when we are computing the effect of a pile engine, it will be necessary to estimate first the quantity of percussion that is equivalent to the resistance and friction opposed to the pile; as no momentum short of this, or even just equal to it, will produce any effect, and when the momentum is greater than this, it is only the difference between the two that is effective in producing motion in the pile. And to this circumstance must be attributed the many erroneous solutions that appeared a few years back to the question, " What must be the height of a pile engine to produce the greatest effect in a given time?" This question, at first sight, appears to be the same with asking how high must the pile engine be to produce the greatest momentum in a given time; but using this principle, the solution always gave the height $= 0$; that is, the greatest effect will be produced when the rammer is left at rest on the top of the pile. But if instead of proceeding thus, we first estimate, or find from experiment, the height to which the rammer must be drawn, in order that its momentum may be equivalent to the resistance of the pile, and then considering the difference between this and any greater momentum to be only the effective part, a very rational solution will be obtained. But before entering upon the solution of this problem, it will be proper to offer a few farther remarks with regard to the comparability of percussion and pressure, because the solution ultimately depends upon a proper comparison of those quantities, and a want of due attention to which seems to have been the cause of the erroneous results generally deduced in the solution of this problem. Without, indeed, entering into a discussion concerning the congruity or incongruity of these forces, it is obvious that they may be so employed as to produce the same or equal results. A nail, for example, may be driven to a certain depth into a block of wood by the blow of a hammer, or it may be sunk to the same depth by the pressure of a heavy body; whence, and from numerous other instances, it is obvious that pressure and percussion, whether congruous or incongruous in their nature, are at least comparable in their effects. With regard to the above problem, the resistance and friction of the soil against the pile may, as above observed, be considered as a pressure, and the object of our inquiry is, to establish a comparison between this resistance and pressure of the soil, and the momentum of the ram, or what part of the whole generated momentum of the latter is employed in overcoming the resistance of the former, in order to determine the effective part of the stroke, which ought alone to be considered in estimating the maximum effect; because any single momentum, less than that which is equivalent to the resistance, would produce no effect whatever. Now it being admitted that pressure and momentum are at least comparable in their effects, it must also be granted that there is some determinate momentum of the ram equivalent to the resistance of the pile; and the height necessary for producing this momentum must be the first object of our research, which it is obvious, from various circumstances that may arise in the application of the engine, can only be determined by experiment.

PILLOW, a block of timber whereon the inner end of the bowsprit is supported.

PILOT, the officer who superintends the navigation, either upon the sea coast or upon the main ocean. It is, however, more particularly applied to the person charged with the ship's course on or near the sea-coast, and into the roads, rivers, bays, havens, &c. within his particular district. The regulations with regard to pilots in the royal navy are as follow:—The commanders of the king's ships, in order to give all reasonable encouragement to so useful a body of men as pilots, and to remove all objections to his majesty's service, are strictly charged to treat them with good usage, and an equal respect with warrant officers. The purser of the ship is always to have a set of bedding provided on board for the pilots, and the captain is to order the boatswain to supply them with hammocks, and a convenient place to lie in near their duty, and apart from the common men; which bedding and hammocks are to be returned when the pilots leave the ship. A pilot, when conducting one of his majesty's ships in pilot water, shall have the sole charge and command of the ship, and may give orders for steering; setting, trimming, or furling the sails; tacking the ship, or whatever concerns the navigation; and the captain is to take care that all the officers and crew obey his orders. But the captain is diligently to observe the conduct of the pilot, and if he judges him to behave so ill as to bring the ship into danger, he may remove him from the command and charge of the ship, and take such measures for her preservation as shall be judged necessary; remarking upon the log book the exact hour and time when the pilot was removed from his office, and the reasons assigned for it. Captains of the king's ships employing pilots in foreign parts of his majesty's dominions, shall, after performance of the service, give a certificate thereof to the pilot, which being produced to the proper naval officer, he shall cause the same to be immediately paid; but if there be no naval officer there, the captain of his majesty's ship shall pay him, and send him the proper vouchers, with his bill, to the navy board, in order to be paid as bills of exchange. Captains of his majesty's ships employing foreign pilots to carry the ships they command into or out of foreign ports, shall pay them the rates due by the establishment or custom of the country, before they discharge them; whose receipts being duly vouched, and sent with a certificate of the service performed to the navy board, they shall cause them to be paid with the same exactness as they do bills of exchange.

*Branch* PILOT, is one who is duly authorized by the Trinity Board to pilot ships up particular channels or rivers.

**PIMENTO**, Jamaica pepper, or allspice. *See* Myrtus.

**PIN**, in Commerce, a little necessary instrument made of brass wire, chiefly used by women in adjusting their dress. When the wire is received at the manufactory, it is wound off from one wheel to another, and passed through a circle of a smaller diameter in a piece of iron. When reduced to its proper size, it is straightened by drawing it between iron pins, fixed in a board in a zigzag manner. It is afterwards cut into lengths of about four yards, and then into smaller pieces, every length being sufficient for six pins. Each end of these is ground to a point. This operation is performed by boys, who each sit with two small grindstones before him turned by a wheel. Taking up a handful, he applies the wires to the coarsest of the two stones, moving them round that the points may not become flat. He then gives them a smoother and sharper point on the other stone: a lad of 12 years of age can point 16,000 in an hour. When the wire is pointed, a pin is taken off from each end, till it is cut into six pieces. The next operation is to form the heads or head-spinnings, as it is termed. This is done by a spinning wheel: one piece of wire is with rapidity wound round another; and the interior one being drawn out, leaves a hollow tube between the circumvolutions. It is then cut by shears, every two turns of the wire forming one head. These are softened by throwing them into iron pans, and placing them in a furnace till they are red hot. As soon as they are cold, they are distributed to children, who sit with anvils and hammers before them. These they work with their feet by means of a lathe. They take up one of the lengths, and thrust the blunt end into a quantity of the heads which lie before them; catching one at the extremity, they apply it immediately to the anvil and hammer, and by a motion or two of the foot, the point and the head is fixed together in much less time than can be described, and with a dexterity that can only be acquired by practice. The pins are thrown into a copper containing a solution of tin and wine lees. Here they remain for some time, and when taken out assume a dull white appearance: in order to give them a polish, they are put into a tub containing a quantity of bran, which is set in motion by turning a shaft that runs through its centre, and thus, by means of friction, the pins become entirely bright. They are now separated from the bran, which is performed by a mode exactly similar to the winnowing of corn; the bran flying off, and leaving the pin behind it fit for sale.

Needles are made of steel. The first thing in the manufacture of needles, is to pass the steel through a coal fire, and under a hammer to bring it to a round form, then it is drawn through a large hole of a wire-drawing iron, and returned into the fire, and again drawn through a second hole smaller than the first, and thus successively till it has acquired a degree of fineness requisite; observing every time it is drawn to rub it with lard to render it more manageable. The steel thus reduced, is cut to the proper length of the needles; these pieces are flattened at one end to form the eye: they are then put into a fire to soften; then taken out, and the head pierced by a puncheon of well-tempered steel, and laid on a leaden block, to bring out, with another puncheon, the little piece of steel remaining in the eye. The corners of the heads are then filed off, and a little cavity filed on each side of the flat of the head, the point is then formed with a file, and the whole is filed over. They are then laid on a long narrow iron, crooked on one end, to heat red-hot, with charcoal fire; when taken out, are thrown into a bason of cold water to harden. On this operation much depends; too much heat burns them, too little leaves them soft; experience teaches the medium. When thus hardened, they are laid in a shovel on a fire more or less brisk. This tempers them, and takes off their brittleness. They are then straightened one after another with a hammer. The next process is the polishing. The people take 12 or 15,000 needles, and range them in little heaps on a piece of new buckram sprinkled with emery dust; they are then sprinkled with oil of olives. The whole is then made up in a roll, and laid on a polishing table: a thick plank is now passed over the whole, and the needles within become polished. They are then washed in water with soap, and wiped in bran. The good are taken from the bad; the points are tipped with an emery stone turned by a wheel, and then packed up in parcels of 250 each for sale.

**PIN of a Block**, is the axis on which the sheaves revolve being supported by the shell. *Belaying* Pins, pieces of wood or iron fixed in a kind of rail for making fast the small running rigging.

**PINCHBECK**, a factitious metallic substance, being an alloy of zinc three parts, and of copper four.

**PINE**, the *Fir Tree*. Its timber, under the name of deal, is employed as wood-work for the building of houses; for rafters, flooring, doors, the frames of windows, tables, boxes, and other purposes infinitely too various to be enumerated. Frigates, and other ships of large size, have sometimes been constructed of deal; but these are by no means so durable as those built of oak. Much of the deal which we use is imported into this country from Norway, and other northern parts of Europe. That from Christiana, which in London is called yellow deal, and in the country red deal, is frequently brought over in planks, but more commonly in boards about ten inches and half in width. The Scots fir raised in England is equal to the foreign wood in weight and durability, but its grain is generally coarser. We are informed that in some parts of Ireland the bogs are almost entirely filled with the old roots of the Scots fir; and that these are dug up and converted into ropes, which, for sustaining moisture without decay, are found preferable to ropes made of hemp. The outer bark of the fir-tree may be used in the tanning of leather; and it is said that in the northern parts of Europe the soft, white, and fibrous inner bark is, in in times of scarcity, made into a kind of bread. For this purpose it is dried over a fire, reduced to powder, kneaded with water and a small portion of corn flour into cakes, and baked in an oven. Children in Norway are very fond of the fresh bark in the spring of the year, either shaved off with a knife or grated with a rasp.

Common turpentine is the resinous juice chiefly of the Scots fir, obtained by boring holes into the trunks of the trees early in spring, and placing vessels beneath for its reception. It is of a brown colour, and has a strong odour and disagreeable taste. On the distillation of turpentine, an essential oil is produced, called oil of turpentine, which is extremely pungent. When the distillation is continued to dryness, that which is left behind is known by the name of common resin or rosin; but if water be mixed with it while yet fluid, and incorporated by violent agitation, a substance is formed called yellow resin. Common turpentine is mostly employed as an ingredient in the plasters used by farriers. The oil is occasionally used in medicine; and lately it has been considered efficacious in cases of worms. It is much employed by painters for rendering their colours more fluid; as well as in the composition of different kinds of varnish used in floor-cloth, umbrella, and other manufactures. The noxious spirit called gin was formerly flavoured with juniper berries; but as these are now too expensive, oil of turpentine, the taste of which in a slight degree resembles that of juniper, is applied to the same purpose; and very considerable quantities of turpentine are thus consumed. The common resin is used in plasters, for which its great adhesiveness renders it peculiarly applicable. It is also of considerable importance in the arts; and musicians rub the bows and strings of violins with it, to take off the greasy particles which are there collected, as well as to counteract the effects of moisture. Yellow resin is used in plasters, and for other purposes in medicine. Tar is obtained from the roots and refuse parts of the fir-tree by cutting them into billets, piling these in a proper manner in pits or ovens formed for the purpose, covering them partly over, and setting them on fire. During the burning, a black and thick matter, which is the tar, falls to the bottom, and is conducted thence into vessels which are placed to receive it, and from which it is afterwards poured into barrels for sale. Tar is an article of great utility in manufactures, and for various economical purposes. It is much employed for smearing the rigging and other external parts of ships, to prevent their receiving injury from moisture. It has been used in medicine both internally and externally; and particularly tar water, or water impregnated with tar.

*The Weymouth* Pine, is chiefly distinguished by its leaves growing in fives: and its cones being smooth, cylindrical, and longer than the leaves. This species grows wild in North America, and succeeds well in strong land in England. Its timber is white, of more open grain than Scots fir, and not so heavy as that. In America it is principally used for the masts of ships, for which by its toughness it is peculiarly calculated.

The *Scotch Fir*, PINUS SYLVESTRIS, a very useful tree in plantations for protecting other more tender sorts when young. It is also now very valuable as timber:—necessity, the common parent of invention, has taught our countrymen its value. When foreign deal was worth twenty pounds per load, they contrived to raise the price of this to about nine or ten pounds, and it was then thought proper for use; before which period, and when it could be bought for little money, it was deemed only fit for fuel. On the South Downs some plantations of this tree, which have been sold after twenty-five years' growth, at a price which averaged a profit of twenty shillings per annum per acre, on land usually let for sheep-pasture at one shilling and sixpence.

The *Spruce Fir*, PINUS ABIES, a native of Norway, and other northern parts of Europe, is known by its short and four-sided leaves, growing singly, and surrounding the branches, its cones being cylindrical, the scales somewhat square, flattened and notched at the top. The wood of the spruce fir is what the English carpenters usually denominate white deal. It is considered next in value to that obtained from the Scots fir; and is remarkable for having few knots. On account of its lightness, it is peculiarly adapted for packing cases and musical instruments.

**PINION**, in Mechanics, an arbor or spindle, in the body of which are several notches, which catch the teeth of a wheel that serves to turn it round; or it is a lesser wheel that plays in the teeth of a larger one.

**PINK**, a vessel used at sea, masted and rigged like other ships, only that this is built with a round stern; the bends and ribs compassing so as that her ribs bulge out very much. This disposition renders the pinks difficult to be boarded, and also enables them to carry greater burdens than others, for which purpose they are often used.

**PINNA**, in Zöology, a genus belonging to the order of vermes testacea. The animal is a slug.

**PINNACE**, a small vessel used at sea, with a square stern, having sails and oars, and carrying three masts, chiefly used as a scout for intelligence, and for landing of men, &c. One of the boats belonging to a great man of war, serving to carry the officers to and from the shore, is also called the pinnace.

**PINNACLE**, in Architecture, the top or roof of a house terminating in a point.

**PINTLES**, certain pins or hooks fastened upon the back part of the rudder, with their points downwards, in order to enter into and rest upon the googings fixed on the stern post to support the rudder. See the article HELM.

**PINUS**, the *Fir*. *S*ee PINE.

**PIONEERS**, in the art of war, are such as are commanded in from the country, to march with an army for mending the ways, for working on entrenchments and fortifications, and for making mines and approaches.

**PIP**, or PEP, pepia, a disease among poultry, consisting of a white thin skin, or film, that grows under the tip of the tongue, and hinders their feeding.

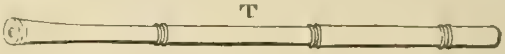
**PIPE**, in Law, a roll in the Exchequer, otherwise called the *Great Roll*.

PIPE also denotes a vessel or measure for wine, containing 126 gallons.

PIPE *Office*, is an office wherein a person, called the clerk of the pipe, makes out leases of crown lands, by warrant from the lord treasurer, or commissioners of the treasury, or chancellor of the exchequer. The clerk of the pipe makes out also accounts of sheriffs, &c. and gives the accomptants their *quietus est*.

**PIPER**, *Pepper*, a genus of the trigynia order, in the diandria class of plants. There is no calix or corolla; the berry is one-seeded. There are 60 species.

**PIPES**, for conveying of water, for pumps, water-engines, &c. are usually of lead, iron, earth, or wood; the latter are usually made of oak or elder. Those of iron are cast in forges; their usual length is from six to eight feet; several of these are commonly fastened together by means of four screws at each end, with leather or old hat between them, to stop the water. Those of earth are made by the potters; these are fitted into one another, one end being always made wider than the other. To join them the closer, and prevent their breaking, they are covered with tow and pitch: their length is usually about that of the iron pipes. The wooden pipes are trees bored with large iron augurs of different sizes, beginning with a less, and then proceeding with a larger, successively; the first being pointed, the rest being formed like spoons, increasing in diameter from one to six inches, or more; the pipes are fitted into the extremities of each other, as here represented, and are sold by the foot. Wooden pipes are bored, either by a borer advancing horizontally, while the wood to be pierced is turned round, in some such manner as in boring of ordnance; or, by causing the timber to be gradually advanced, while the borer turns round; the latter method is the most common. The apparatus most frequently adopted, when the first mover is a stream of water, is that invented by M. Morel.



This machinery, (see Plate *Pile Engines*, &c.) is represented at fig. 6, where the vertical wheel A is put into motion by water descending upon it through a trough or sloping canal: upon the horizontal axle of this wheel is a cog wheel B, which gives motion to the lanterns C, D, the common axis of these lanterns being in a vertical position. The lantern D turns at the same time two cog wheels E and F; the first, E, which is vertical, turns the augur that bores the wood; and the second, F, which is horizontal, has attached to it by a pin which is at a small distance from its centre, a lever or arm H, with a hook at its end, taking into the indentations of one of the wheels of the carriage that carries the wood to be bored. Another lever, I, hanging upon the former, is prevented from falling by a spring, and pushes by its extremity against the notches of the lower end of the same wheel. Thus, as the cog wheel turns round, the carriage-wheel is first pulled forward by the hook and lever H, and then pushed backward as far by the arm I; by this means causing a pinion upon the axle of the carriage wheel to advance the rackwork above it, together with the timber to be bored; so that the timber is advanced by a slight reciprocating motion of the carriage. The augur, being generally some feet in length, plays in holes in two pieces L, L, which retain it in its horizontal position, and thus it forms a cylindrical cavity in the wood, as required.

PIPES, *Tobacco*, are made of various fashions; long, short, plain, worked, white, varnished, unvarnished, and of various colours, &c.

**PIPRA**, the *Manakin*, a genus of birds of the order of passeres. Latham describes 25 species, and five varieties.

**PIRACY**, is the seizing or plundering a vessel on the high seas, without having a commission for that purpose.

**PIRATE**, a sea robber. By stat. 28. Hen. VIII. c. 15. all treasons, felonies, robberies, murders, and confederacies, committed upon the sea, or in any haven, creek, or place, where the admiral has jurisdiction, shall be tried in such shires or places as the king shall appoint by his commission, in like forms as if such offence had been committed upon land, and according to the course of the common law, and the offenders shall suffer death, without benefit of clergy. And by stat. 6 Geo. I. made perpetual, it is enacted, that if any of his majesty's natural born subjects, or denizens of this kingdom, shall commit any piracy or robbery, or any act of hostility, against other his majesty's subjects upon the sea, under colour of any commission from any prince or state, or pretence of authority from any person whatsoever, such offender shall be deemed to be a pirate, felon, and robber; and being duly convicted thereof, according to this act, or the aforesaid act of 23 Hen. VIII. shall have and suffer such pains of death, loss of lands, goods, and chattels, as pirates, felons, and robbers upon the seas, ought to have and suffer. By 18 Geo. II. c. 30, persons committing hostilities, or aiding enemies at sea, may be tried as pirates. Piracies at sea are excepted out of the general pardon, by 20 Geo. II. c. 52.

PIRATE'S *Goods* go to the admiral by grant; but not piratical goods, which go to the king, if the owner is not known.

**PISCES**, the *Fishes* ♓, are the last of the signs in the fixed zodiac, and consequently the last of the Southern and Winter signs: the sun enters it about the 19th of February, and the earth is then just entering into the sign Virgo. Reckoning, however, by the visible zodiac, this sign has taken the place of Aries, and it is chiefly situated on the north side of the equator; the Fishes have therefore become the leaders of the celestial hosts; and on all artificial representations of the heavens, wherein the constellations are laid down according to their recession from the vernal equinox, as established by the intellectual zodiac of Hipparchus, the Sun actually enters Pisces about the 6th of March.

Pisces, *Fishes*, in Natural History, is the fourth class in the Linnæan system, consisting of five orders, *viz.* Abdominales, Apodes, Cartilaginii, Jugulares, and Thoracici. The class is described as having incumbent jaws; eggs without white; organs of sense; for covering, imbricate scales; fins for supporters; they swim in water; respiration is performed by means of gills, which supply the place of lungs. Air is equally necessary to the existence of fish, as it is to other animals. This process, in fishes, as breathing in the human subject, is carried on during sleep, and is repeated about twenty-five times in a minute; and the necessity of it is evinced, from the circumstance of fish being certainly killed in water, from which air is taken away by means of the air-pump, or excluded by very severe frost. Should the free play of the gills be even suspended, or their covers kept from moving, by a string tied round them, the fish would fall into convulsions, and die in a few minutes. It is said, likewise, that though the branchial apparatus be comprised in a small compass, its surface, when fully extended, would occupy many square feet; a fact, that may convince the most sceptical, of the numberless convolutions and ramifications in which the included water is elaborated and attenuated, in the course of giving out its air in the respiratory process. Fishes have the organs of sense, some of them probably in a very high degree, and others imperfectly; of the latter kind, are the senses of touch and of taste; but the sense of hearing has now been completely ascertained, which was long doubted, and by some physiologists denied: the organ is contained in the cavity of the head. The organ of smelling is large, and the animals have a power of contracting and dilating the entry to it as they have occasion. It seems to be mostly by their acute smell that they discover their food, for their tongue seems not to have been designed for a very nice sensation, being of a pretty firm cartilaginous substance; and common experience evinces, that their sight is not of so much use to them as their smell in searching for their nourishment.—We now proceed to notice the motion of fishes, for the celerity of which their shape is admirably adapted: hence, vessels designed to be navigated in water, are made to imitate, in some degree or other, the shape of fish; but the rapidity of a ship in sailing before the wind, is not to be compared to the velocity of a fish. The largest fishes are known to overtake a ship in full sail with the greatest ease, to play round it without effort, and to surpass it at pleasure. Every part of the body seems formed for despatch: the fins, the tail, and the motion of the whole backbone, assist in the business; and it is to that flexibility of body which mocks the efforts of art, that fishes owe the great velocity of their motions. The chief instruments in a fish's motion are its fins, air-bladder, and tail; with two pair, and three single fins, it will migrate a thousand leagues in a season, and without indicating any visible symptoms of languor or fatigue. By means of the air bladder, fishes can increase or diminish the specific gravity of their body. When they contract it, and press out the air, the bulk of the body is diminished, and the fish sinks as far as it pleases: on relaxing the operation, the bladder acquires its natural size, the body becomes specifically lighter, and the fish is enabled to swim near the surface. The tail, in the last place, may be regarded as the rudder, directing the motions of the fish, to which the fins are only subservient. With respect to the nourishment of fishes: they are mostly carnivorous, though they seize upon almost any thing that falls in their way, and not uncommonly devour their own offspring; they seem, indeed, to manifest a particular predilection for whatever they can swallow possessed of life. Fishes can, however, notwithstanding their natural voracity, live long, apparently, without food; but they, perhaps, in vases and other ornamental vessels, feed on insects too small for the human eye to see; or, it has been thought, they may have the power of chemically decomposing water. A few species of fishes, as the eel, blenny, &c. are viviparous; but by far the greater number are produced from eggs. Fishes have different seasons for depositing their spawn. Some, which live in the depths of the ocean, are said to choose the winter months; but, in general, those with which we are acquainted, choose the hottest months in summer, and prefer such water as is somewhat tepified by the beams of the sun. They then leave the deepest parts of the ocean, which are the coldest, and shoal round the coasts, to swim up the fresh water rivers, which are warm as they are comparatively shallow, depositing their eggs where the sun's influence can most easily reach them, and seeming to take no farther charge of their future progeny. Of the eggs thus deposited, scarcely one in a hundred brings forth an animal, as they are devoured by all the lesser fry which frequent the shores, by aquatic birds near the margin, and by the larger fish in deep water. Still, however, the sea is amply supplied with inhabitants; and notwithstanding their own rapacity, and that of various tribes of fowls, the numbers that escape are sufficient to relieve the wants of a considerable portion of mankind. Indeed, when we consider the fecundity of a single fish, the amount will seem astonishing. If we should be told, for example, that a single being could in one season produce as many of its kind as there are inhabitants in England, it would strike us with surprise; yet the cod annually spawns, according to Lewenhoeck, above nine million of eggs contained in a single roe. The flounder is commonly known to produce above one million; and the mackarel above five hundred thousand; a herring of a moderate size, will yield at least ten thousand; a carp, of fourteen inches in length, contained, according to Petit, two hundred and sixty-two thousand two hundred and twenty-four; and another, sixteen inches long, contained three hundred and forty-two thousand one hundred and forty-four; a perch deposited three hundred and eighty thousand six hundred and forty; and a female sturgeon, seven million six hundred and fifty-three thousand two hundred. The viviparous species are by no means so fruitful; yet the blenny brings forth two or three hundred at a time, all alive and playing round the parent together.

**PISCIS AUSTRALIS**, the *Southern Fish*, is one of the old constellations, the brilliant of which was a subject of great study by the Egyptians and Ethiopians, as I have already observed. The river of Aquarius is lost at the mouth of the Fish, as our astronomers depict the constellations. The brilliant Fomalhaut is nearly on the same meridian with Markab in Pegasus; but Kircher's Planispheres are destitute of this symbol; yet we may conceive its high antiquity from the place it holds among the celestial host, and its relation with Aquarius.

**PISCIS VOLANS**, the *Flying Fish*, situated on the Antarctic circle, contains eight stars all under the 4th magnitude.

**PISOLIT**, a mineral found at Carlsbad, in Bohemia. It has the form of round masses composed of concentric layers, and containing a grain of sand in their centre. Colour white, often grayish, reddish, or yellowish.

**PISTOLE**, a Spanish gold coin, of which there are quadruple, double, and half pistoles.

**PISTON**, in Mechanics, denotes a short cylinder working within another hollow cylinder, as in water or air pumps, and some other machines.

**PISUM** Sativum. (*The Pea.*) The gray hog pea used to be the only one sufficiently hardy for culture in the fields; but since the improvement of our agriculture, we have all the finer varieties cultivated in large quantities. The seed used is about two bushels and a half per acre, and the produce varies from three to ten quarters. The varieties of peas are many, but the principal ones used in agriculture are the early Charlton pea; the Dwarf marrow: the Prussian blue. All these are dwarf kinds, and as the demand for this article in war time is great for the navy and army, if the farmer's land will suit, and produce such as will boil, they will fetch a considerably greater price in proportion. The varieties that are found to boil are either used whole, or split, which is done by steeping them in water till the cotyledons swell, after which they are dried on a kiln, and passed through a mill; which just breaking the husk, the two cotyledons fall apart.

**PITCH**, a tenacious oily substance, drawn chiefly from pines and firs, and used in shipping, medicine, and other arts; or it is more properly tar, inspissated by boiling it over a slow fire.

**Pitch**, *Mineral*, has a strong resemblance to common pitch. Colour black, dark brown, or reddish. Specific gravity from 1.45 to 2. Does not stain the fingers. On a white iron it flames with a strong smell, and leaves a quantity of gray ashes.

**PITCHING**, is the vertical vibration which the length of a ship makes about her centre of gravity, or the moment by which she plunges her head and afterpart alternately into the hollow of the sea. This motion may proceed from two causes; the waves which agitate the vessel, and the wind upon the sails which makes her stoop at every blast. The first absolutely depends upon the agitation of the sea, and is not susceptible of inquiry; and the second is occasioned by the inclination of the masts, and may be submitted to certain established maxims. When the wind acts upon the sails, the masts yield to its effort with an inclination which increases in proportion to the length of the mast, to the augmentation of the wind, and to the comparative weight and distribution of the ship's lading. The repulsion of the water to the effort of gravity, opposes itself to this inclination, or at least retains it by as much as the repulsion exceeds the momentum or absolute effort of the mast, upon which the wind operates. At the end of each blast, when the wind suspends its action, this repulsion lifts the vessel; and these successive inclinations and repulsions produce the movement of pitching, which is very inconvenient; and when it is considerable, will greatly retard the course as well as endanger the mast and strain the vessel.

**PITCHSTONE.** This stone, which occurs in different parts of Germany, France, and other countries, has obtained its name from some resemblance which it has been supposed to have to pitch. It is most usually in amorphous pieces of different sizes.

**PITH**, in Vegetation, the soft spongy substance contained in the central parts of plants and trees.

**PIVOT**, a foot or shoe of iron, or other metal, usually conical, or terminating in a point, by which a body, intended to turn round, bears on another fixed and at rest, and performs its revolutions. The pivot usually bears or turns round in a sole, or piece of iron or brass, hollowed out to receive it.

**PLACE**, in Philosophy, that part of immoveable space which any body possesses or occupies, having to space the same relation that time has to duration.

**Place** has various denominations, as *absolute, relative, primary*, &c. which will be readily comprehended without any formal definitions.

**PLAGUE**, *in the time of Justinian the Emperor.*—The following dismal relation of this dire calamity is given in the eloquent language of Mr. Gibbon.—Ethiopia and Egypt have been stigmatized in every age as the original source and seminary of the plague. In a damp, hot, stagnating air, this African fever is generated from the putrefaction of animal substances, and especially from the swarms of locusts, not less destructive to mankind in their death than in their lives. The fatal disease which depopulated the earth in the time of Justinian and his successors, first appeared in the neighbourhood of Pelusium, between the Serbonian bog and the eastern channel of the Nile. From thence, having as it were a double path, it spread to the east over Syria, Persia, and the Indies, and penetrated to the west, along the coast of Africa, and over the continent of Europe. In the spring of the second year, Constantinople, during three or four months, was visited by the pestilence; and Procopius, who observed its progress and symptoms with the eyes of a physician, has emulated the skill and diligence of Thucydides in the description of the plague of Athens. The infection was sometimes announced by the visions of a distempered fancy; and the victim despaired as soon as he had heard the menace and felt the stroke of an invisible spectre. But the greater number in their beds, in the streets, in their usual occupation, were surprised by a slight fever; so slight, indeed, that neither the pulse nor the colour of the patient gave any signs of the approaching danger. The same, the next, or the succeeding day, it was declared, by the swelling of the glands, particularly those of the groin, of the arm-pits, and under the ear; and, when these buboes or tumors were opened, they were found to contain a coal or black substance of the size of a lentil. If they came to a just swelling and suppuration, the patient was saved by this kind and natural discharge of the morbid humour. But, if they continued hard and dry, a mortification quickly ensued, and the fifth day was commonly the term of his life. The fever was often accompanied by lethargy or delirium; the bodies of the sick were covered with black pustules or carbuncles, the symptoms of immediate death; and, in the constitutions too feeble to produce an eruption, the vomiting of blood was followed by the mortification of the bowels. To pregnant women the plague was generally mortal. Youth was the most pernicious season, and the female sex was less susceptible than the male; but every rank and profession was attacked with indiscriminate rage; and many of those who escaped were deprived of the use of their speech, without being secure from a return of the disorder. The physicians of Constantinople were zealous and skilful, but their art was baffled by the various symptoms and pertinacious vehemence of the disease: the same remedies were productive of contrary effects, and the event capriciously disappointed their prognostics of death or recovery. The order of funerals and right of sepulchres were confounded; those who were left without friends or servants lay unburied in the streets, or in their desolate houses; and a magistrate was authorized to collect the promiscuous heaps of dead bodies, to transport them by land or water, and to inter them in deep pits beyond the precincts of the city. Their own danger, and the prospect of public distress, awakened some remorse in the minds of the most vicious of mankind; the confidence of health again revived their passions and habits. The plague had touched the person of Justinian himself. During his sickness, the public consternation was expressed in the habits of the citizens, and their idleness and despondency occasioned a general scarcity in the capital of the East. Contagion is the inseparable symptom of the plague, which, by mutual respiration, is transfused from the surfeited persons to the lungs and stomach of those who approach them. While philosophers believe and tremble, it is singular that the real danger should have been denied by a people most prone to vain and imaginary terrors (the French.) Yet, the fellow-citizens of Procopius were satisfied, by some short and partial experience, that the infection could not be gained by the closest conversation; and this persuasion might support the assiduity of friends and physicians in the care of the sick, whom inhuman prudence would have condemned to solitude and despair. But the fatal security, like the predestination of the Turks, must have aided the progress of the contagion; and those salutary precautions, to which Europe is indebted for her safety, were unknown to the government of Justinian. No restraints were imposed on the free and frequent intercourse of the Roman provinces; from Persia to France the nations were mingled and infected by wars and emigrations; and the pestilential odour, which lurks for years in a bale of cotton, was imported, by the abuse of trade, into the most distant regions. The mode of its propagation is explained by the remark of Procopius himself, that it always spread from the sea-coast to the inland countries: the most sequestered islands and mountains were successively visited; the places which had escaped the fury of its first passage, were alone exposed to the contagion of the ensuing year. The winds might diffuse that subtle venom; but, unless the atmosphere be previously disposed for its reception, the plague would soon expire in the cold or temperate climates of the earth. Such was the universal corruption of the air, that the pestilence, which burst forth in the 15th year of Justinian, A.D. 542, was not checked or alleviated by any difference of the seasons. In time its first malignity was abated and dispersed; the disease alternately languished and revived: but it was not till the end of a calamitous period of fifty-two years that mankind recovered their health, or the air resumed its pure and salubrious quality. No facts have been preserved to sustain an account, or even a conjecture, of the numbers* that perished in this extraordinary mortality. I only find that, during three months. five, and at length ten, thousand people died each day at Constantinople; that many cities of the East were left vacant; and that, in several districts in Italy, the harvest and the vintage withered on the ground. The triple scourge of war, pestilence, and famine, afflicted the subjects of Justinian; and his reign is remarkable for a visible decrease of the human species, which has never been repaired, in some of the fairest countries of the globe.

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* It is probable that no less than an hundred millions of human beings fell victims to this contagion in the Roman empire alone!!!

Plague *Water*, one of the compound waters of the shops, distilled from mint, rosemary, angelica roots, &c.

PLAIN, in general, an appellation given to whatever is smooth and even, or simple, obvious, and easy to be understood; and consequently, stands opposed to rough, enriched, or laboured. A plain figure, in geometry, is an uniform surface, from every point of whose perimeter, right lines may be drawn to every other point in the same. A plain angle is one contained under the two lines or surfaces, in contradistinction to a solid angle. The doctrine of plain triangles, as those included under three right lines, is termed plain trigonometry.

Plain *Number*, is a number that may be produced by the multiplication of two numbers into one another; thus 20 is a plain number produced by the multiplication of 5 into 4.

Plain, *Place*, *locus planus*, or *locus ad planum*, among the ancient geometricians, denoted a geometrical locus, when it was a right line or a circle, in opposition to a solid place, which was an ellipsis, parabola, or hyperbola.

Plain *Problem*, in Mathematics, is such a problem as cannot be solved geometrically, but by the intersection either of a right line and a circle, or of the circumferences of two circles; as, given the greatest side, and the sum of the other two sides of a right-angled triangle, to find the triangle, as also to describe a trapezium that shall make a given area of four given lines.

Plain *Table*, in Surveying, a very simple instrument, whereby the draught of a field is taken on the spot, without any future protraction.

PLAN, in general, denotes the representation of something drawn on a plane, such are maps, charts, ichnographies, &c.

PLANE. *See* Geometry.

Plane, is a term used by shipwrights, implying the area or imaginary surface contained within any particular outlines, as, the plane of elevation, the plane of projection, the horizontal plane.

Plane, in Joinery, an edged tool, or instrument, for paring and shaving of wood smooth.

PLANET, a wandering star, as distinguished from the fixed stars, which always preserve the same relative position with respect to each other. Hence it follows that comets and satellites are included, according to the original signification of this term, under the same general denomination; in fact, the early astronomers had no idea of comets being permanent bodies, and as they were also unacquainted with any satellite but the moon, which with the sun was supposed to revolve about the earth, it was natural for them to class both under the same general appellation. But modern astronomers, in order to make a distinction between these, define a planet to be a celestial body revolving about the sun as a centre, with a moderate degree of eccentricity; thus excluding comets, the eccentricity of whose orbits is very considerable, and the satellites, which revolve about their primaries as the primaries do about the sun. These last are, however, sometimes called secondary planets. *See* Astronomy.

We have given, under the several articles Eccentricity, Distance, Orbit, Period, &c. the several particulars included under those denominations, as also under the names of the several planets, the respective elements of each; and we have therefore, in this place, only to state a few popular observations relative to the probable nature, motion, appearances, &c. of these celestial bodies; and to give a general view of the elements and other particulars of the planetary system. First, then, all the planets perform their revolutions in elliptical orbits about the sun, which is situated in one of the foci of the ellipse; the orbit of each planet lies in a plane, which passes through the centre of the sun; those which are nearest the centre move with a greater velocity than those that are more remote; the same planet is also quicker or slower according as it is in that part of its orbit which is nearer or more remote from the central body; and all their motions are performed in the same order from west to east, or according to the order of the signs. The motions and distances of the several planets are related to each other by invariable laws, *viz.* that the cubes of their periodic times of revolution, are as the squares of their distances from the sun; and that equal areas are described by the same planet in equal times; that is, if we suppose a line drawn from the sun to a planet, and to move about it as a centre, that line will pass over or describe equal areas in equal times; therefore since the periods of the planetary revolution are accurately known from observation, we may hence find the exact proportional distance of all these bodies. *See* Kepler's Laws.

It has been discovered by means of spots, observable on the discs of the planets, that they have a rotatory motion about their own axes, the time of which, however, seems to follow no particular law either with regard to their magnitude or distance from the sun. Hence it appears that these bodies have each a diversity of seasons, their spring, summer, autumn, and winter, resembling those in our planets; they have likewise the same alternations of day and night, and in short, that they are fitted to the accommodation of inhabitants.

> "With constitutions fitted to the spot
> Where Providence all-wise has fixed their lot."

The excessive heat and cold experienced in those regions, in consequence of their proximity or remoteness from the sun, as have been supposed and even computed by some authors, appear to be wholly imaginary. Uranus, the most distant planet in our system, has a temperature perhaps not at all different from Mercury, who revolves much nearer to the sun than ourselves. The light and heat received and experienced in our globe, seems to depend more upon the constitution of the atmosphere than any other cause; or why have we mountains covered with perpetual snow, and whence that diminution of light and heat experienced by aërial voyagers, but in consequence of the extreme rarity of the air in the upper regions? and if this be granted, it follows immediately that a simple modification in the atmospheres of the several planets, would render the temperature of each supportable even by terrestrial inhabitants.

The idea of the temperature of the several planets depending upon their distances from the sun, arises from considering that body, not simply as the cause of heat, but as an immense mass of fire, possessing in itself, independent of any other agent, the power of heat; whereas there is every reason to conclude that it is only by a combination of the solar rays with certain parts of our atmosphere that the effect is produced. Water poured upon unslacked lime generates heat in the combined mass, and if we could imagine a being existing in such a mass, we should have no difficulty in conceiving that he would attribute that quality to the water, which we attribute to the sun although in this case the contrary is evident. We cannot doubt then, without presumptuously limiting the power and wisdom of the Deity, that each of these planets is peopled with millions of beings engaged like us in the anxious vicissitude of life, and probably each having its philosophers and astronomers contemplating this immense globe as a mere speck in the starry firmament. Nor must we stop here; it is also highly probable that every fixed star is another centre, about which planets are revolving, as those of our system do about the sun. Instead therefore of one sun and one world, as the ignorant imagine, reason and contemplation point out to us millions of suns and millions of worlds, each peopled by myriads of inhabitants, dispersed through infinite space, to which our system appears but as a mere point or atom, and is almost lost in the immensity of the creation.

What an august, what an amazing conception, if human imagination can conceive it, does this give of the works of the Creator! Thousands of thousands of suns multiplied without end, and ranged all round us, at immense distances from each other, attended by ten thousand times ten thousand worlds, all in rapid motion, yet calm, regular, and harmonious, invariably keeping the paths prescribed them; and these worlds peopled with myriads of intelligent beings, formed for an endless progression in perfection and felicity. If so much power, goodness, and magnificence, be displayed in the material creation, which is the least considerable part of the universe, how great, wise, and good must He be, who made and governs the whole!"

*Elements* of the **Planets**, are certain quantities which are necessary to be known in order to determine the theory of their elliptic motion. Astronomers reckon seven of those quantities, of which five relate to the elliptic motion, *viz*. 1. The duration of the sidereal revolution. 2. The mean distance or semi-axis major. 3. The eccentricity, from which is derived the greatest equation of the centre. 4. The mean longitude of the planet at any given epoch. 5. The longitude of the perihelion at the same epoch.

The two other elements relate to the position of the orbit, and are, 1. The longitude at a given epoch of the nodes of the orbit with the ecliptic. 2. The inclination of the orbit to this plane.

**Planet** *Wheels*, are wheels by whose mutual connexion a variable angular motion, such as that of the radius vector of a planet in its orbit, may be exhibited. The common contrivance now in use for this purpose was invented, we think, by Desaguliers; it consists of two elliptical wheels, connected either by teeth running into each other, or by a band; these wheels revolve on their foci, and while the driving ellipses move uniformly, the radius vector of the other has the required motion. A much older, and at the same time far better, method than that of Desaguliers, was the invention of M. Joli de Dijon, of which the following is an account. If it be desired to move a wheel of 24 teeth by a pinion of 6, in such a manner that in some parts of its revolution it shall move as swiftly as if it had but 12 teeth, and in other parts as slowly as if it had 48 teeth, the method of accomplishing this is as follows:—

1. Describe the rectangle L M N O, fig. 7, (see Plate *Pile Engines*, &c.) having its side N O equal to the radii of the great wheel, and the pinion taken together, and its breadth L N equal to their thickness; which last must be greater, the more considerable the inequality of the proposed movement. Let N O be so divided in Q, that Q O may be to Q N, as 6 to 48, that is to say, reciprocally as the velocity of the pinion to the greatest velocity of the wheel. Also divide L M in P, in the proportion of 6 to 12, or reciprocally, as the velocity of the pinion to the least velocity of the wheel. Then join P Q, and draw as many lines S R parallel to L M, as there are intended to be teeth in the great wheels; upon which write the degrees of velocity they express, which are in the inverse ratio of their lengths.

2. Let two truncated cones be formed in the lathe; one equal to that which would be formed by the revolution of the trapezoid L P Q N about L N as an axis; and the other equal to what would be formed by the revolution of the trapezoid P Q M O about the axis M O. On the largest of these two cones let the circles generated by the revolution of the points P, T, Q, be marked and distinguished by the same numeral figures as the corresponding parallels of the rectangle L O. Upon the two bases of the conic frustum describe radial lines, which shall make angles at the centre, fig. 9, in the same proportion to each other, as the intended velocities of the wheel, as expressed in fig. 8, and let teeth be cut in the curve surface of the cone corresponding with these lines; after this, look on the circles that express the different velocities, and have been traced on the same surface, to find what part of each tooth ought to remain opposite its corresponding radius, and cut or file the rest away. Thus will the teeth lie in an oblique or elliptical curve, on the conical surface, as is exhibited in the figure by a darker shade. The pinion must be made of a regular conic shape, as is shewn at M O, in fig. 9. By this contrivance, the largest or widest teeth will always meet the largest part of the pinion, and the narrowest will correspond with the smallest part; on which account, though the motion of the pinion be uniform, the wheel will be carried unequably, according to the assigned law; and in a similar manner may planet wheels be described to exhibit any other proposed variation.

**PLANETARIUM**, an astronomical machine, contrived to represent the motions and various aspects of the heavenly bodies, parallelism of the earth's axis, together with its diurnal motions, and by these means to explain the beautiful variety of the seasons, and other terrestrial and celestial phenomena, has ever been considered as one of the noblest efforts of mechanical genius. Among the variety of machines contrived for these purposes, the *Planetarium*, or *Portable Orrery*, fig. 1, is best adapted for representing the celestial motions.

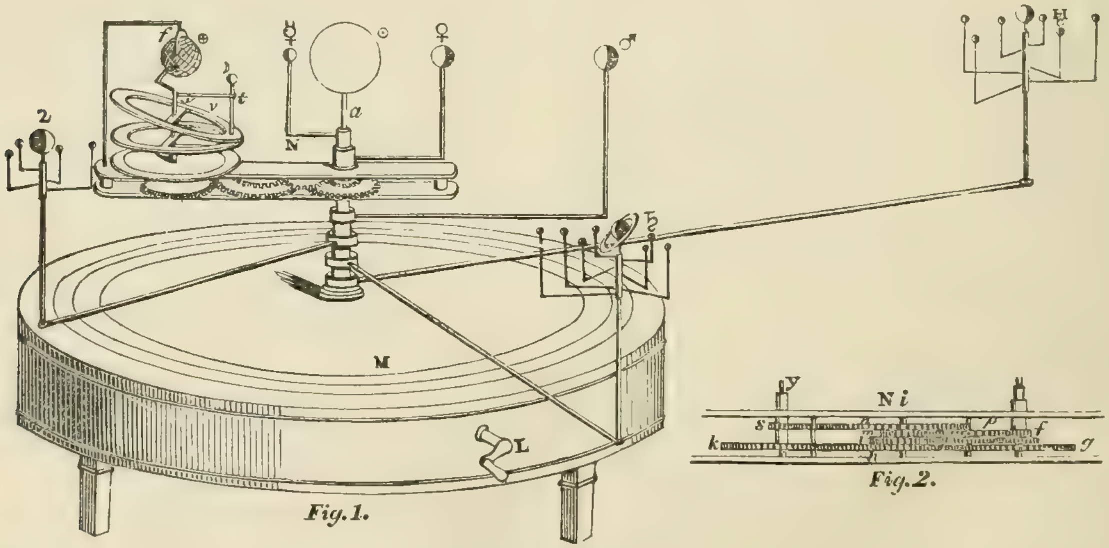


*Fig. 1.*

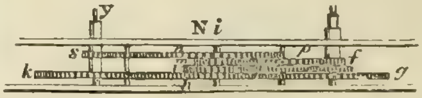


*Fig. 2.*

A planetarium may be considered, in short, as a diametrical section of the universe, in which the upper and lower hemispheres are suppressed. The upper plate is to answer for the ecliptic; on this are placed, in two opposite but corresponding circles, the days of the month, and the signs of the ecliptic, with their respective characters; by this plate you may set the planetary balls so as to be in their respective places on the ecliptic for any day in the year. Through the centre of this plate you observe a very strong stem, on which is a brass ball to represent the sun: round the stem are different sockets to carry the arms by which the several planets are supported. The planets are represented by ivory balls, having the hemisphere which is next the sun white, the other black, to exhibit their respective phases: and these planets may be taken off, or put on with ease, as occasion may require. About the primary planets are placed the secondary planets, or moons, which are, in some instruments, only moveable by the hand. By turning the handle, all the planets are put in motion, moving round that ball which represents the sun. And, if we take the earth's motion as a standard, the other planets move with the same relative velocities and periodical times with which they traverse through space. The planetarium is furnished with a lamp, which when it is placed into the socket on which the brass sun is fitted, throws the reflection of the sun's light upon all the planets, and gives their proper phases, &c.

In the Planetarium exhibited in the engraving, ☉ represents the Sun, which is fixed firmly to a wire *a*, and has no motion; ☿ is the planet Mercury, revolving round the Sun; ♀ is the planet Venus; ♁ represents the Earth, and ☾ the Moon revolving round it; *f* is a segment of brass called the Earth's terminator, which shews that all the parts of the Earth behind it are not illuminated by the Sun; ♂ is the planet Mars; ♃ Jupiter and his four Satellites; ♄ Saturn, with his ring and seven satellites; ♅ Herschel, and six satellites. L is a small winch, which when turned gives motion to Mercury and Venus, and shews the Earth's annual motion round the Sun, its diurnal motion, and the Moon's motion round the Earth. The projection in the middle of the circular board M, consists of the following parts:—A steel wire A, whose lower end is screwed to a bridge under the board, and which carries the Sun; over this is put a tube, on whose lower end a worm wheel, worked by a worm on the arbour of the winch L above mentioned, is fixed; and to the upper end the frame of wheels N, with the Earth and Moon. Over these is a conical tube, which has a flaunch at its lower end, and is fastened to the board M by three screws; the arms carrying the planets Mars, Jupiter, Saturn, and Herschel, are fitted stiffly upon this tube, so as not to turn, unless they are moved. These planets do not move by turning the winch, but are to be set by hand, as also their satellites. In the frame of wheels N, figs. 1 and 2, *g* is the first wheel, which is fixed to the wire *a*, fig. 1, and is without any motion; this works into another wheel *h* of the same size, fixed to the spindle *i*. The wheel *h* works another wheel *k* of the same size, on whose spindle *y*, fig. 1, the Earth is fixed. Besides the wheel *h*, the spindle *i* has three other wheels *l m n*, fixed on it. The wheel *l* turns *c*, which works a pinion above the wheel *g*, carrying the planet Mercury in fig. 1: this pinion has a hollow spindle, and goes over the wire *a*. The wheel *m* on the spindle *i* works into *p*, which gives motion to the pinion *g*, (whose spindle goes over the spindle of the pinion which carries Mercury,) and has the planet Venus, in fig. 1, fixed to it. The large wheel *n* on the spindle *i* turns, by intermediate wheels, the pinion *S*, whose arbor goes over the spindle carrying the Earth: this has an arm for the Moon fixed to it. The wire *t*, to which the Moon is fixed, slides up and down through a hole in the end of the arm; and the lower end of the wire rests on a circular ring *v*, whose plane is parallel to the plane of the Moon's orbit, so that, as the arm turns round, the wire is pushed up by the inclination of the ring, and falls by its own weight. Beneath this is a ring, with divisions on it, shewing the Moon's age. When the winch L is turned, it works the worm wheel beneath the board M, and moves the frame N, fig. 1, with the Earth round the Sun; and as the wheel *g* is fixed, the wheel *h* is turned by rolling round it; and as *k* (which it works) is of the same size with the other two, it turns the Earth, so that its axis always points to the pole. The wheel *l*, by means of the wheel *o*, turns the pinion, which carries Mercury in fig. 1. The wheel *m*, with the wheel *p*, turns *g*; and the planet Venus in fig. 1, and the wheel *n*, turns the pinion *s*, and the Moon, as before described.

PLANETARY, something that relates to the planets.

Planetary *System*, is the system or assemblage of the planets, primary and secondary, moving in their respective orbits, round their common centre the sun.

PLANIMETRY, that part of geometry which considers lines and plane figures without any regard to heights or depths. Planimetry is particularly restricted to the mensuration of planes and other surfaces: as contradistinguished from stereometry or the mensuration of solids, or capacities of length, breadth, and depth.

PLANISPHERE, a projection of the sphere and its various circles on a plane; as upon paper, or the like. In this sense, maps of the heavens and the earth, exhibiting the meridians and other circles of the sphere, may be called planispheres.

Planisphere is sometimes, also considered as an astronomical instrument, used in observing the motions of the heavenly bodies; being a projection of the celestial sphere upon a plane representing the stars, constellations, &c. in their proper situations, distances, &c. as the astrolabe, which is a common name for all such projections. In all planispheres the eye is supposed to be in a point, viewing all the circles of the sphere, and referring them to a plane beyond them, against which the sphere is as it were flattened; and this plane is called the plane of projection, which is always some one of the circles of the sphere itself, or parallel to some one of them. Among the infinite number of planispheres which may be furnished by the different planes of projection and the different positions of the eye, there are two or three that have been preferred to the rest. Such as that of Ptolemy, where the plane of projection is parallel to the equator; that of Gemma Frisius, where the plane of projection is the colure, or solstitial meridian, and the eye of the pole of the meridian, being a stereographical projection; or that of John de Royas, a Spaniard, whose plane of projection is a meridian, and the eye placed in the axis of that meridian at an infinite distance; being an orthographical projection, and called the anelemma.

PLANKING, the act of covering and lining the sides of a ship with planks, which is sometimes by the artificers called laying on the skin. This completes the process of ship-building.

PLANTAGO Lanceolata. (*Rib Grass.*) This is a perennial plant, and very usefully grown, either mixed with grasses, or sometimes alone: it will thrive in any soil, and particularly in rocky situations. It is much grown on the hills in Wales, where, by its roots spreading from stone to stone, it is often found to prevent the soil from being washed off, and has been known to keep a large district fertile, which would otherwise be only a bare rock. Sheep are particularly fond of it. About four pounds, sown with other seeds for pasture, will render a benefit in any situation that wants it. Twenty-four pounds is usually sown on an acre when intended for the sole crop, and sown under corn.

PLANTING, in Agriculture and Gardening. The first thing in planting, is to prepare the ground before the trees or plants are taken out of the earth, that they may remain out of the ground as short a time as possible; and the next is to take up the trees or plants in order to their being transplanted. In taking up the trees, carefully dig away the earth round the roots, so as to come at their several parts to cut them off; for if they are torn out of the ground without care, the roots will be broken and bruised, to the great injury of the trees. When you have taken them up, the next thing is, to prepare them for planting, by pruning the roots and heads. And first, prune off all the bruised or broken roots, all such as are irregular and cross each other, and all downright roots, especially in fruit trees, shorten the larger roots in proportion to the age, the strength, and nature of the tree; observing, that the walnut, mulberry, and some other tender-rooted kinds, should not be pruned so close as the more hardy sorts of fruit and forest trees: in young fruit trees, such as pears, apples, plums, peaches, &c. that are one year old from the time of their budding or grafting, the roots may be left only about eight or nine inches long; but in older trees, they must be left of a much greater length; but this is only to be understood of the larger roots, for the small ones must be chiefly cut quite out, or pruned very short.

The next thing is, the pruning of their heads, which must be differently performed in different trees, and the design of the trees must also be considered; thus, if they are intended for walls or espaliers, it is best to plant them with the greatest part of their heads, which should remain on till they begin to shoot in the spring, when they must be cut down to five or six eyes, at the same time taking care not to disturb the roots. But if the trees are designed for standards, you should prune off all the small branches close to the place where they are produced, as also the irregular ones which cross each other; and after having displaced these branches, you should also cut off all such parts of branches as have, by any accident, been broken or wounded; but by no means cut off the main leading shoots, which are necessary to attract from the root, and thus promote the growth of the tree.

Having thus prepared the trees for planting, you must now proceed to place them in the earth; but if the first trees have been long out of the ground, so that the fibres of the roots are dried, place them eight or ten hours in water before they are planted, with their heads erect, and the roots only immersed in it, which will swell the dried vessels of the roots, and prepare them to imbibe nourishment from the earth. In planting them, great regard should be had to the nature of the soil, for if that is cold and moist, the trees should be planted very shallow, and if it is a hard rock or gravel, it will be better to raise a hill of earth where each tree is to be planted, than to dig into the rock or gravel, and fill it up with earth, as is too often practised, by which means the trees are planted as in a tub, and have but little room to extend their roots.

The next thing to be observed is, to place the trees in the hole in such a manner that the roots may be about the same depth in the ground as before they were taken up; then break the earth fine with a spade, and scatter it into the hole, so that it may fall in between every root, that there may be no hollowness in the earth. Having filled up the whole, gently tread down the earth with your feet, but do not make it too hard, which is a great fault, especially if the ground is strong or wet. Having thus planted the trees, they should be fastened to stakes driven into the ground, to prevent their being displaced by the wind, and some mulch laid about the surface of the ground about their roots: as to such as are planted against walls, their roots should be placed about a foot from the wall, to which the heads should be nailed, to prevent their being blown up by the wind. The seasons for planting are various, according to the different sorts of trees, or the soil in which they are planted; for the trees whose leaves fall off in winter, the best time is the beginning of October, provided the soil is dry; but if it is a very wet soil, it is better to defer it till the latter end of February, or the beginning of March; and for many kinds of evergreens, the beginning of April is by far the best season; though they may be safely removed at Midsummer, provided they are not to be carried very far; but you should always make choice of a cloudy wet season.

**Plants**, in Botany, organic vegetable bodies, consisting of roots and other parts.

*Increase of Plants or Vegetables.*—The seeds of many kinds of vegetables are so numerous, that if the whole produce of a single plant were put into earth, and to come to maturity in due course, the whole surface of the earth would be covered with them in a few years. Thus, the hyosciamus, which of all known plants, produces the greatest number of seeds, would for this purpose require no more than four years. According to some experiments, it has been found, that one stem of the hyosciamus produces more than 50,000 seeds, and if we admit the number to be only 10,000, it would amount, at the fourth crop, to 1,000,000,000,000,000; and as the whole surface of the earth is calculated to contain no more than 5,507,634,452, 576,256 square feet, it will be seen, that if we allow only a square foot to each plant, the whole surface of the earth would be insufficient to contain the produce of a single hyosciamus at the end of the fourth year.

**PLASTER**, in Pharmacy, is defined to be an external application, of a harder consistence than our ointments; these are to be spread according to the different circumstances of the wound, place, or patient, either upon linen or leather.

**Plaster**, among Builders, &c. The plaster of Paris is a preparation of several species of gypsums, dug near Mont Maitre, a village in the neighbourhood of Paris; whence the name.

**PLAT**, a sort of plaited cordage formed of the yarns of old rope twisted into foxes. It is used to wind about that part of the cable which lies in the hawse-hole, where it would otherwise be greatly injured by the continual friction produced by the agitation of the ship in stormy weather. *See* the articles Freshen and Service.

**PLATALEA**, the *Spoonbill*, in Ornithology, a genus belonging to the order of grallæ. The beak is plain, and dilates towards the point into an orbicular form; the feet have three toes, and are half-palmated. There are three species.

**PLATANUS**, the *Plane Tree*, a genus of the polyandria order, in the monœcia class of plants. There are two species, the Oriental and American.

**PLATBAND** *of a Door* or *Window*, is used for the lintel, where that is made square, or not much arched; these platbands are usually crossed with bars of iron when they have a great bearing, but it is much better to ease them by arches of discharge built over them.

**PLATE Backstay**, is a piece of iron used instead of a chain to confine the lower dead-eye of the backstay.

*Foot-hook*, or *Futtock* **Plates**, are iron bands fitted to the lower dead-eyes of the top-mast shrouds, which passing through holes in the edge of the top, are attached to the upper ends of the futtock-shrouds.

**PLATFORM**, is a number of planks laid together, forming a kind of floor for any temporary or particular purpose.

**Platform**, in the Military art, an elevation of earth, on which cannon are placed, to fire on the enemy; such are the mounts in the middle of curtins On the ramparts there is always a platform, where the cannon are mounted. It is made by the heaping up of earth on the rampart; or by an arrangement of madriers rising insensibly, for the cannon to roll on, either in a casement or an attack on the outworks. All practitioners are agreed that no shot can be depended on, unless the piece can be placed on a solid platform; for if the platform shakes with the first impulse of the powder, the piece must likewise shake, which will alter its direction, and render the shot uncertain.

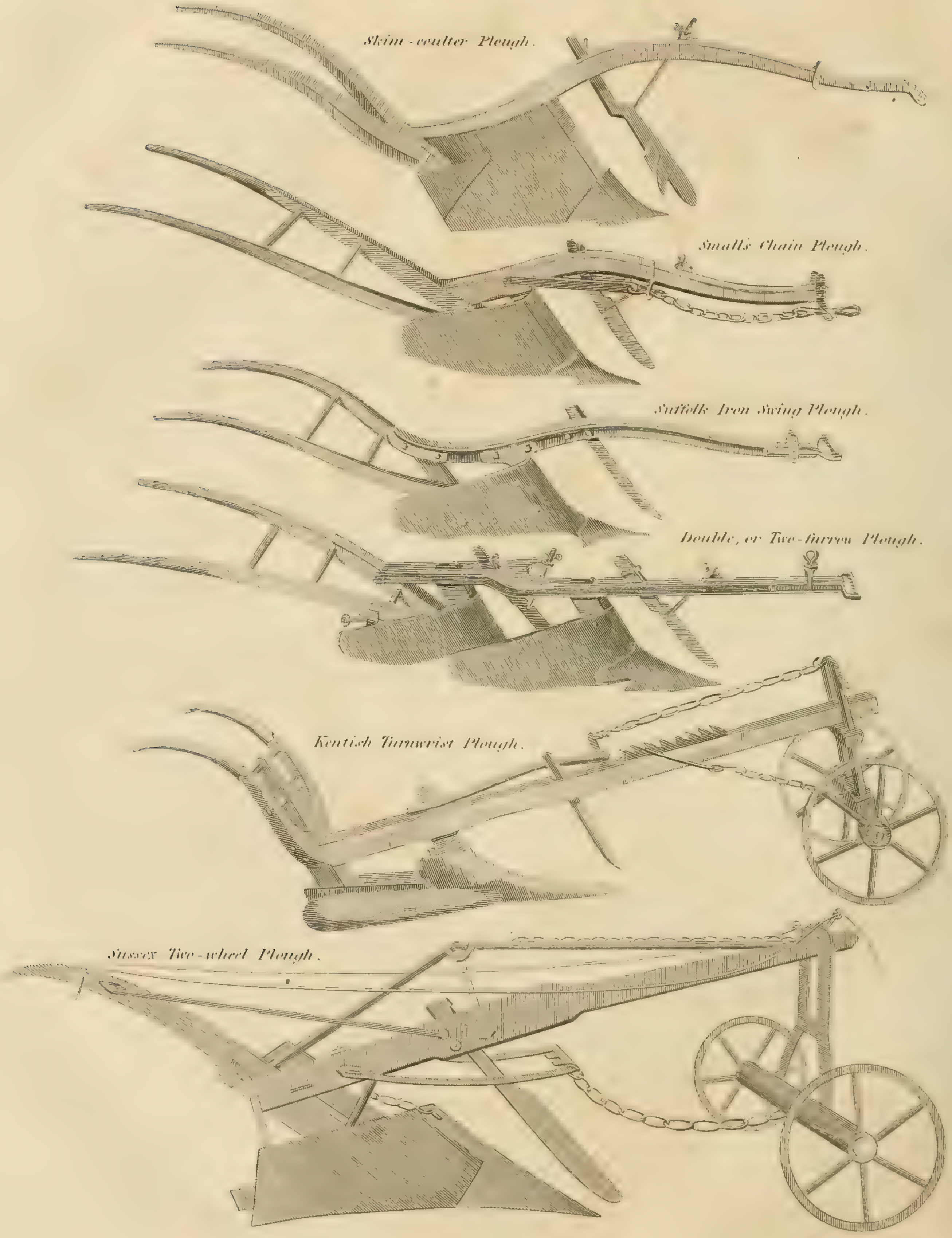
**Platform**, or *Orlop*, in a ship of war, a place on the lower deck, abaft the main-mast, between it and the cockpit, and round about the main capstan, where provision is made for the wounded men in time of action.

**PLATINA**, is one of the metals, for the discovery of which we are indebted to our contemporaries. Its ore has recently been found to contain likewise four new metals,—palladium, iridium, osmium, and rhodium, (which see,) besides iron and chromium. Pure or refined platina is by much the heaviest body in nature. Its specific gravity is 21 54. It is very malleable, though considerably harder than either gold or silver; and it hardens much under the hammer. Its colour on the touchstone is not distinguishable from that of silver. Pure platina requires a very strong heat to melt it; but when urged by a white heat, its parts will adhere together by hammering. This property, which is distinguished by the name of welding, is peculiar to platina and iron, which resemble each other likewise in their infusibility. Platina is not altered by exposure to air, neither is it acted upon by the most concentrated simple acids, even when boiling or distilled from it. The aqua regia best adapted to the solution of platina, is composed of one part of the nitric, and three of muriatic acid. The solution does not take place with rapidity. From its hardness, infusibility, and difficulty of being acted upon by most agents, platina is of great value for making various chemical vessels. Platina may be drawn into very fine wire. There are two oxides of platina. It is dissolved in chlorine, and sulphate of platina may be obtained by passing a current of sulphuretted hydrogen gas through the nitro-muriatic solution. A fulminating powder is obtained from platina.

**PLATING**, is the art of covering baser metals with a thin plate of silver, either for use or for ornament. It is said to have been invented by a spur-maker, not for show, but for real utility. Till then the more elegant spurs in common use were made of solid silver; and from the flexibility of that metal, they were liable to be bent into inconvenient forms by the slightest accident. To remedy this defect, a workman at Birmingham contrived to make the branches of a pair of spurs hollow, and to fill that hollow with a slender rod of steel iron. Finding this a great improvement, and being desirous to add cheapness to utility, he continued to make the hollow larger, and of course the iron thicker and thicker, till at last he discovered the means of coating an iron spur with silver in such a manner as to make it equally elegant with those which were made wholly of that metal. The invention was quickly applied to other purposes; and to numberless utensils, which were formerly made of brass or iron, are now given the strength of these metals, and the elegance of silver, for a small additional expense.

**PLATONIC Year**, or the *Great Year*, is the period of time determined by the revolution of the equinoxes, upon a supposition of the precession going on uniformly till they have made one complete revolution. *See* Precession.

**PLATOON**, in the Military art, a small square body of forty or fifty men, drawn out of a battalion of foot, and placed be-



*Skim-coulter Plough.*

*Small's Chain Plough.*

*Suffolk Iron Swing Plough.*

*Double, or Two-furrow Plough.*

*Kentish Turnwrist Plough.*

*Sussex Two-wheel Plough.*

tween the squadrons of horse, to sustain them; or in ambuscades, straits, and defiles, where there is no room for whole battalions or regiments.

**PLATYPUS**, a quadruped of the order of bruta, but with a mouth shaped like the bill of a duck; feet webbed.

**PLEA**, that which either party alleges for himself in court. These are divided into pleas of the crown and common pleas. Pleas of the crown are all suits in the king's name against offences committed against his crown and dignity, or against his crown and peace. Common pleas are those that are held between common persons. Common pleas are either dilatory, or pleas to the action. Pleas dilatory, are such as tend merely to delay or put off the suit, by questioning the propriety of the remedy rather than by denying the injury. Pleas to the action, are such as dispute the very cause of suit. 3 Black. 301.

**PLEADINGS**, in general, signify the allegations of parties to suits, when they are put into a proper and legal form; and are distinguished in respect to the parties who plead them, by the name of bars, replications, rejoinders, sur-rejoinders, rebutters, sur-rebutters, &c. and though the matter in the declaration of court does not properly come under the name of pleading, yet, being often comprehended in the extended sense of the word, it is generally considered under this head.

**PLEASURE BOAT**, a boat fitted up for receiving company to sail up and down a river, harbour, or lake, &c.

**PLEIADES**, in Astronomy, an assemblage of stars in the neck of the constellation Taurus.

**PLENE ADMINISTRAVIT**, a plea pleaded by an executor or administrator, where they have administered the deceased's estate faithfully and justly before the action brought against them.

**PLENUM**, in Physics, denotes, according to the Cartesians, that state of things wherein every part of space is supposed to be full of matter; in opposition to a vacuum.

**PLENUS FLOS**, in Botany, a full flower; a term expressive of the highest degree of luxuriance in flowers. The petals in full flowers are so multiplied as to exclude all the stamina, and frequently to choak up the female organ, so that such flowers, though delightful to the eye, are vegetable monsters. Flowers with more than one petal are most liable to this; such as the ranunculus, anemony, poppy, myrtle, &c. &c. Flowers with one petal only are but seldom subject to this fulness; these, however, are not totally exempt, as may be seen in the double polyanthus, hyacinth, crocus, &c. In flowers with one petal, the mode of luxuriance, or impletion, is by a multiplication of the divisions of the limb, or upper part. In flowers with more than one petal, is a multiplication of the petals or nectarium.

**PLEURISY**, in Medicine, a violent pain in the side, attended with an acute fever, a cough, and a difficulty of breathing.

**PLEURONECTES**, the *Flounder*, in Natural History, a genus of fishes of the order thoracici. Under this genus is included the *Hallibut*, the *Plaise*, the *Dab*, the *Flounder*, the *Sole*, the *Turbot*, &c. which require no particular description.

**PLOT**, in dramatic Poetry, is sometimes used for the fable of a tragedy or comedy, but more particularly the knot or intrigue which makes the embarrassment of any piece. The unravelling puts an end to the plot.

**PLOT**, in Surveying, the plot or draught of any field, farm, or manor, surveyed with an instrument, and laid down in the proper figure and dimensions.

**PLOTTING**, among Surveyors, is the art of laying down on paper, &c. the several angles and lines of a tract of ground surveyed by a theodolite, &c. and a chain.

**PLOTUS**, or **DARTER**, a genus of birds of the order anseres. The generic character is bill straight, pointed toothed; nostrils a slit near the base; face and chin naked; legs short, all the toes connected. Of this genus there are three species.

**PLOUGH**, in Agriculture, a machine for turning up the soil, contrived to save the time, labour, and expense, that without this instrument must have been employed in digging land to prepare it for the sowing of all kinds of grain.

**PLOUGH**, among Bookbinders, is a machine for cutting the edges of the leaves of books smooth.

**PLUG**, a piece of timber formed like the frustum of a cone, and is used for different purposes, as, *Hawse-Plugs*, are made to stop the hawse holes when the cables are unbent, or not in them. Their use is to prevent the water coming in when the Ship pitches. *Shot* PLUGS, are used to stop the breaches made in the bottom of a ship by cannon-balls, and are formed of various sizes, according to the different sizes of shot.

**PLUMBERY**, the art of casting and working lead, and using it in building.

**PLUM-TREE.** *See* PRUNUS.

**PLUMMET**, among Artificers, denotes a perpendicular to the horizon; so called as being commonly erected by means of a plummet.

**PLUMMING**, among Miners, is the method of using a mine-dial, in order to know the exact place of the work where to sink down an air-shaft, or to bring an adit to the work, or to know which way the load inclines when any flexure happens in it.

**PLUNDER**, in sea language, a name given to the effects of the officers and crew of a prize, when pillaged by the captors. In the military art, plunder is a booty of any kind.

**PLUNGER**, in Mechanics, the same with the forcer of a pump.

**PLURALITY.** If any person having one benefice with cure of souls of eight pounds a year in the king's books, shall accept another of whatsoever value, and be instituted and inducted into the same, the former benefice shall be void; unless he has a dispensation from the archbishop of Canterbury, who has power to grant dispensations to chaplains of noblemen and others, under proper qualifications, to hold two livings, provided they are not more than thirty miles distant from each other, and provided that he resides in each for a reasonable time every year, and that he keeps a sufficient curate in that in which he does not ordinarily reside.

**PLUS** in Algebra, a character marked thus +, used for the sign of addition.

**PLUSH**, in Commerce, a kind of stuff leaving a sort of velvet nap, or shag, on one side, composed regularly of a woof of a single woollen thread, and a double warp, the one wool, of two threads twisted, the other goat's or camel's hair; though there are some plushes entirely of worsted, and others composed wholly of hair.

**PLUVIOMETER**, a machine for measuring the quantity of rain that falls.

**PLYING**, in a nautical sense, is the act of making, or endeavouring to make, a progress against the direction of the wind, hence *a good Plyer* is a vessel that makes great advances in this manner of sailing.

**PNEUMATICS**, may be defined the science which treats of the properties of air in general, or perhaps with more propriety the term expresses the science that investigates the mechanical properties of elastic and aëriform fluids, such as their weight, density, compressibility, and elasticity.

In the article AIR PUMP, page 21, I have shewn how the *weight*, or *specific gravity*, of the air may be ascertained. The density, compressibility, and elasticity of the air were illustrated in my explanation of the common air pump, its construction and principle of action, page 20 column 2.

I shall in this article confine myself to experiments in pneumatical science, as best calculated to illustrate its principles.

*Preliminary Facts.*—The air is a fluid which we breathe; for it envelopes our globe to a considerable height around it. Clouds and vapours float in it, and the whole is called the *atmosphere*. As it is possessed of gravity, like other fluids, it must press upon bodies in proportion to the depth at which they are immersed in it; and it also presses in every direction, in common with all other fluids. It however differs from all other fluids in the four following particulars:—1. It can be compressed into less space than it naturally possesses. 2. It cannot be congealed or fixed as other fluids may. 3. It is of a different density in every part upward from the earth's surface, decreasing in its weight, bulk for bulk, the higher it rises; and therefore must also decrease in density. 4. It is of an elastic or springy nature, the force of its spring being equal to its weight.

People unacquainted with the principles of natural philosophy, would not suppose that the air by which we are surrounded, is a material substance, like other visible matter. Being invisible, and affording no resistance to the touch, it seems to them extraordinary, to consider it as a solid and material substance, yet a few experiments will convince them that it is really matter, possessing weight, and the power of resisting bodies that press against it.

*Experiment* 1.—Take a bladder that has not the neck tied, you may press the sides together and squeeze it into any shape. Blow into this bladder, and tie a string fast round the neck; you cannot then, without breaking the bladder, press the sides together; you can scarcely alter its figure by pressure. Whence then arise these effects? When empty, you could press the bladder into any form; but the air with which it is filled prevents this; the resistance you experience, when it is filled with air, proves that air is matter.

*Experiment* 2.—We say a vessel is empty, when we have poured out of it the water it contained: but if a glass jar be plunged with its mouth downward into a vessel of water, there will but very little water get into the jar, because the air, of which it is full, keeps the water out. Or, throw a bit of cork into a bason of water, put an empty tumbler over it with the mouth downwards, force it down through the water; the cork will shew the surface of the water within the tumbler, and you will see that it will not rise so high within as without the glass; nor, if you press ever so hard, will it rise to the same level. The water is, therefore, prevented from rising within the tumbler, by some substance which occupies the inside. This substance is air.

*Exp.* 3. Open a pair of common bellows, stop up the nozzle securely; you cannot shut the bellows, which seems filled with something that yields a little, like wool; unstop the nozzle, the air will be expelled, it may be felt against the hand, and the bellows will now shut.—When the air is at rest we can move in it with facility; nor does it offer a perceptible resistance, except the motion be quick, or the surface opposed to it considerable; but when this is the case, its resistance is very perceptible, as may be easily perceived by the motion of a fan. When air is in motion, it constitutes wind, which is nothing more than a current or stream of air, varying in its force according to its velocity.

The invisibility of air, therefore, is only the consequence of its transparency; but it is possessed of all the common properties of matter. We say a vessel is empty, in the usual way of speaking, when it is filled with air.

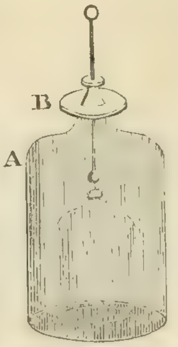
*The Mechanical Properties of Air.*—But it is possible to empty a vessel of the air it contains, by which means we shall be able to discover several properties of this fluid. The instrument or machine by which this operation is performed, is called an AIR PUMP. *See* pages 20—23.

4. To demonstrate the weight of air by experiment, take a hollow copper ball, or other vessel, which holds a quart, (wine measure), having a neck to screw on the plate of the air pump; weigh it when full of air, exhaust it, and weigh it when empty; it will have lost 16 grains, the weight of a quart of air. But a quart of water weighs 14624 grains: this divided by 16, quotes 914 in round numbers; so that water is 914 times as heavy as air, near the surface of the earth.

When the receiver is placed upon the plate of the air pump without exhausting it, it may be removed again with the utmost facility, because there is a mass of air under it that resists, by its elasticity, the pressure on the outside; but exhaust the receiver, thus removing the counter pressure, and it it will be held down to the plate by the weight of the air upon it.

5. To determine what the pressure of the air amounts to. The surface of a fluid exposed to the air, is pressed by the weight of the atmosphere equally on every part, and remains at rest. If the pressure be removed from any particular part, the fluid yields in that part, and is forced out of its situation.

Into the receiver A put a small vessel with quicksilver, or any other fluid, and through the collar of leathers at B, suspend a glass tube, hermetically sealed, over the small vessel. Exhaust the receiver, let down the tube into the quicksilver, which will not rise into the tube as long as the receiver continues empty. Re-admit the air, the quicksilver will ascend. The reason is this: upon exhausting the receiver, the tube is likewise emptied of air; and therefore, when it is immersed in the quicksilver, and the air re-admitted into the receiver, the surface of the quicksilver is pressed upon by the air, except that portion which lies above the orifice of the tube; consequently it must rise in the tube, and continue so to do, until the weight of the elevated quicksilver presses as forcibly on that portion which lies beneath the tube, as the weight of the air does on every other equal portion with the tube. Take a common syringe of any kind, and having pushed the piston to the farthest end, immerse it into water; draw up the piston, the water will follow, because, when the piston is pulled up, the air is drawn out of the syringe with it, and the pressure of the atmosphere is removed from the part of the water immediately under it; consequently the water is obliged to yield in that part to the pressure on the surface.

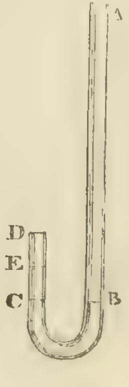


6. Upon this principle those pumps called *sucking* pumps act: the piston fitting tightly the inside of the barrel, by being raised up, removes the pressure of the atmosphere from that part, and consequently the water is drawn up by the pressure upon the surface. The pressure of the atmosphere is then the cause of the ascent of water in pumps; a column of water 33 feet high is a counterpoise to one as high as the atmosphere. As mercury is fourteen times as heavy as water, a column of that fluid need only be $\frac{1}{14}$ of the length of one of water, to form an equal counterpoise to the pressure of the air; and accordingly, having filled with mercury a glass tube about three feet long, hermetically sealed at one end, invert it into a small bason of mercury, and the mercury will rise to the height of about $29\frac{1}{2}$ inches, and there remain suspended, leaving at the top of the tube a space or perfect vacuum; the column of mercury varies in height, and consequently the pressure of the air is different at different times. This phenomenon, too remarkable to be long unobserved, led to the observation that the changes in the height of the mercury were accompanied, or very quickly succeeded, by alterations in the weather. The instrument obtained the name of the weather glass: from its also measuring the weight of the atmosphere, it is called the Barometer, which is merely a tube filled with mercury, and inverted into a bason of the same. *See* BAROMETER, p. 91.

7. Take a receiver, open at the top, and cover it with your hand; exhaust the receiver, and thereby take off the pressure from the palm of the hand: you will then feel it pressed down by immense weight, so as to give pain that would soon be insupportable, and endanger the fracture of your hand.

8. If the top of the receiver be covered by a piece of flat glass, upon exhausting it, the glass will be broken to pieces by the incumbent weight; and this would happen to the receiver itself, but for its arched top, that resists the weight better than a flat surface. This experiment may be varied, by tying a a piece of wet bladder over the open mouth of the receiver, and leaving it to dry until it becomes as tight as a drum. Upon exhausting the receiver, you will perceive the bladder rendered concave, and it will yield more and more, until it break with a loud report occasioned by the air striking forcibly against the inside of the receiver.

9. Air, one of the most elastic bodies in nature, is easily compressed into less compass than it commonly occupies; and when the pressure is removed, it regains its former bulk.



Let mercury be poured into a bent tube, A B C D, open at both ends, to a small height, as B C then stopping the end D with a cork or otherwise air-tight, measure the length of confined air D C, and pour mercury into the other leg A B, till the height above the surface of that in C D be equal to the height at which it stands in the barometer at the time. Then it is plain, that the air in the shorter leg will be compressed with a force twice as great as at first, when it possessed the whole space C D; for then it was compressed only with the weight of the atmosphere, but now it is compressed by that weight, and the additional equal weight of a column of mercury. The surface of the mercury will now be at E; and it will be found upon measuring it, that the space D E, into which the air is now compressed, is just half the former C D. If another column of mercury were added, equal to the former, it would be reduced into one-third of the space it formerly occupied. Hence the density of the air is proportional to the force that compresses it.

As all the parts of the atmosphere gravitate, or press upon each other, the air next the surface of the earth is more compressed and denser than what is at some height above it, in the same manner as wool thrown into a pit. The wool at the bottom having all the weight of what was above it, would be squeezed into a less compass; the layer or stratum above it, would not be pressed so much; the one above that, still less; and so on, till the upper one, having no weight over it, would be in its natural state. This is the case with the air, or atmosphere that surrounds our earth, and accompanies it in its motion round the sun. On the top of lofty buildings, but still more on those of mountains, the air is less dense than at the level of the sea. The height of the atmosphere has never yet been exactly ascertained; on account of its elasticity, it may extend to an immense distance, becoming rarer in proportion to its distance from the earth. It is observed, that at a greater height than 45 miles, it does not refract the rays of light from the sun; and this is usually considered as the limit of the atmosphere. In a rarer state it may extend much farther, and this is by some thought to be the case, from the appearance of certain meteors which have been reckoned to be 70 or 80 miles distant, and whose light is thought to depend upon their coming through our atmosphere. A cubic inch of such air as we breathe, would be so much rarefied at the altitude of 500 miles, that it would fill a sphere equal in diameter to the orbit of Saturn.

10. There is a contrivance for supporting a guinea and a feather, and letting them drop at the same instant. If let fall while the receiver is full of air, the guinea will fall quicker than the feather; but if the receiver be exhausted, they both arrive at the bottom at the same instant, which proves that all bodies would fall to the ground with the same velocity, if it were not for the resistance of the air, which impedes most the motion of those that have the least momentum or weight. In this experiment, the observers ought to look at the bottom of the receiver, otherwise they will not be able to see whether the guinea and feather fall at the same instant.

11. Take a receiver, having a brass cap fitted to the top with a hole in it; fit one end of a dry hazel branch about an inch long, tight into the hole, and the other end tight into a hole quite through the bottom of a small wooden cup; pour quicksilver into the cup, exhaust the receiver, and the pressure of the outward air on the surface of the quicksilver will force it through the pores of the hazel, whence it will descend in a beautiful shower into a glass cup placed under the receiver to catch it.

12. Put a wire through the collar of leathers on the top of the receiver, and fix a bit of dry wood on the end of the wire within the receiver; exhaust the air, push the wire down so as to immerse the wood in a jar of quicksilver on the pump-plate; this done, let in the air, and upon taking the wood out of the jar and splitting it, its pores will be found full of quicksilver, which the force of the air drove into the wood.

13. Set a square phial upon the pump-plate, and having covered it with a wire cage, put a close receiver over it, exhaust the air out of the receiver; in doing which, the air will also make its way out of the phial, through a small valve in its neck —when the air is exhausted, turn the cock below the plate to readmit the air into the receiver: and as it cannot get into the phial again, because of the valve, the phial will be broken into pieces by the pressure of the air upon it. Had the phial been round, it would have sustained this pressure like an arch.

14. To shew the elasticity of air; tie up a very small quantity in a bladder, put it under the receiver; exhaust the air, the bladder (having nothing to act against it) will expand by the force of the air within it; upon letting the air into the receiver again, it will overpower that in the bladder, and press its sides close together.

If the bladder so tied be put into a wooden box, and have 20 or 30 pounds weight of lead placed upon it, and the box be covered with a close receiver; upon exhausting the air out of the receiver, that confined in the bladder will expand and raise up the lead by the force of its spring.

15. If a rat, mouse, or bird, be put under a receiver, and the air be exhausted, the animal will be at first oppressed as with a great weight, then grow convulsed, and at last expire in agonies. This experiment is too shocking to be practised, and we therefore substitute a machine called the *lungs-glass*, in place of the animal.

If a butterfly be suspended in a receiver, by a fine thread tied to one of its horns, it will fly about in the receiver as long as it continues full of air; but if the air be exhausted, though the animal will not die, and will continue to flutter its wings, it cannot remove itself from the place where it hangs, in the middle of the receiver, until the air be let in again, and then the animal will fly about as before.

16. Put a cork into a square phial, and fix it in with wax or cement; and put the phial on the pump plate with the wire cage, and cover it with a close receiver; then exhaust the air out of the receiver, and the air that was corked up in the phial will break it outwards by the force of its spring, because there it no air left on the outside of the phial to act against that within it.

17. Put a shrivelled apple under a close receiver, exhaust the air, the spring of the air within the apple will plump it out, and cause the wrinkles to disappear: but upon letting the air into the receiver again, to press upon the apple, it will return to its former shrivelled state.

Take a fresh egg, cut off a little of the shell and film from its smaller end, put the egg under a receiver, and pump out the air; all the contents of the egg will be forced into the receiver, by the expansion of a small bubble of air contained in the greater end between the shell and the film.

18. Put some warm beer into a glass, set it on the pump, cover it with a close receiver, and then exhaust the air; the air therein will expand itself, and rise up in innumerable bubbles to the surface of the beer; and thence it will be taken away with the other air in the receiver. When the receiver is nearly exhausted, the air in the beer, which could not disentangle itself quick enough to get off with the rest, will now expand itself so as to cause the beer to have all the appearance of boiling; and the greatest part of it will go over the glass.

19. Put some water into a glass, and a bit of dry wainscot or other wood into the water; cover the glass with a close receiver, and exhaust the air; the air in the wood having liberty to expand itself, will come out plentifully, and make the water to bubble about the wood, especially about the ends, as the pores lie lengthwise. A cubic inch of dry wainscot has so much air in it, that it will continue bubbling for nearly half an hour together.

20. Let a piece of cork be suspended by a thread at one end of a balance, and counterpoised by a leaden weight, suspended in the same manner, at the other. Let this balance be hung to the inside of the top of a large receiver; set it on the pump, and exhaust the air, the cork will preponderate, and shew itself to be heavier than the lead; let in the air again, the equilibrium will be restored. The reason is, since the air is a fluid, and all bodies lose as much of their absolute weight in it as is equal to the weight of their bulk of the fluid, the cork being the larger body, loses more of its real weight than the lead; and therefore must be heavier, to balance it under the disadvantage of losing some of its weight. This disadvantage being taken off by removing the air, the bodies gravitate according to their real quantities of matter, and the cork which balanced the lead in air, shews itself to be heavier when in vacuo.

21. Set a lighted candle upon the pump, cover it with a tall receiver. If the receiver hold a gallon of air, the candle will burn a minute; and having gradually decayed from the first instant, it will go out; which shews that a constant supply of fresh air is as necessary to feed flame as to support animal life. The moment the candle goes out, the smoke will ascend to the top of the receiver, and form a cloud; upon exhausting the air, the smoke will fall down to the bottom of the receiver, and leave it clear at the top. This shews that smoke does not ascend on account of its being positively light, but because it is lighter than air; and its falling to the bottom when the air is taken away, shews that it is not destitute of weight. So most sorts

of wood ascend or swim in water; and yet there are none who doubt of the wood's having gravity or weight.

22. Set a receiver, open at top, on the air-pump, cover it with a brass plate and wet leather; having exhausted it of air, let the air in again at top through an iron pipe, making it pass through a charcoal flame at the end of the pipe; when the receiver is full of that air, lift up the cover, and let down a mouse or bird into the receiver; the burnt air will immediately kill it. If a candle be let down into that air, it will go out directly; but by letting it down gently, it will drive out the impure air and good air will get in.

23. Set a bell on the pump-plate, having a contrivance so as to ring it at pleasure, and cover it with a receiver; then make the clapper strike against the bell, and the sound will be very well heard; exhaust the receiver of air, if the clapper be made to strike ever so hard against the bell, it will make no sound: this shews that air is absolutely necessary for the propagation of sound.

*Of condensed Air.*—We now proceed to shew that the air can be condensed, or pressed into less space than what it generally occupies, by an instrument called a *condenser*; see page 23 for an engraving of the machine. It consists of a brass barrel containing a piston, which has a valve opening downwards: as the piston is raised, the air passes through the valve; as the piston is pushed down, the air cannot return, and is therefore forced through a valve at the bottom of the barrel, that allows it to pass into the receiver, but prevents it returning. At every stroke of the piston, more air is thrown into the receiver, which is of very thick and strong glass. The receiver is held down upon the plate by a bar, firmly screwed to two upright props, and the air is let out of the receiver by a cock. A great variety of experiments may be performed by means of condensed air. Thus the sound of a bell is much louder in condensed than in common air; and a phial that would bear the pressure of the common atmosphere, when the air is exhausted from the inside, will be broken by condensing the air around it.

*The Air Gun.*—This pneumatic instrument will drive a bullet with great violence by means of condensed air, forced into an iron ball by a condenser; but if the ball be not very good, it is apt to burst, and injure the operator. In 1820 a man was killed in Yorkshire by the bursting of the air-ball of an air gun. There are many contrivances used in constructing air-guns; some have a small barrel contained within a large one; and the space between the two barrels serves for the reception of condensed air. The magazine air-gun differs from the common one only by having a serpentine barrel which contains ten or twelve balls: these are brought into the shooting barrel successively, by means of a lever; and they may be discharged so fast as to be nearly of the same use as so many different guns: see Air Gun, page 23.

**POA, Annua.** (*Annual Meadow-Grass.*) This, the most general plant in all nature, grows in every situation where there is vegetation. It has been spoken of as good in cultivation, and has had the term Suffolk grass applied to it, from its having grown in that county.

**Poa** *Aquatica*, (*Water Meadow-Grass,*) is quite an aquatic, but is eaten when young by cattle, and is very useful in fenny countries: it is highly ornamental, and might be introduced into ponds for the same purpose as Arundo *phragmites*: it might also be planted with Festuca *elatior* and Phalaris *arundinacea*, in wet dug-out places, where it would be useful as fodder, and form excellent shelter for game.

**Poa** *Fluitans*, (*Flote Fescue-Grass,*) would be, of all others, the most nutritive and best plant for feeding cattle; but it thrives only in water. It is highly recommended by the editor of Curtis's Observations on British Grasses, 5th edition. Cattle are very fond of it; but it is not to be cultivated, except in ponds, being perfectly aquatic Linnæus speaks of the seeds being collected, and sold in Poland and Germany as a dainty for culinary purposes; but it is never seen used here, neither are the seeds to be collected in great quantities. Stillingfleet speaks highly of its merits in a water meadow, and also quotes Ray's account of the famous meadow at Orchiston, near Salisbury. There this, as well as Poa *trivialis*, most certainly is in its highest perfection; but the real and general value of grasses, or other plants, must not be estimated by local instances.

**Poa** *Pratensis*, (*Smoothed-stalked Meadow-Grass,*) is also a grass of considerable merit, when it suits the soil; it affects a dry situation, and in some such places it is the principal herbage.

**Poa** *Trivialis.* (*Rough-stalked Meadow-Grass.*) Those who have observed this grass in our best watered meadows, and in other low pasture lands, have naturally been struck with its great produce and fine herbage. In some such places, it undoubtedly appears to have every good quality that a plant of this nature can possess; it is a principal grass in the famous Orchiston meadow, near Salisbury; but persons should not be altogether caught by such appearances; for it is in some lands, and such as would produce good red clover, a very diminutive and insignificant plant indeed. When persons wish to introduce it, they should carefully examine their neighbouring pastures, and see how it thrives in such places. The seeds are small, and six pounds would be sufficient for an acre, with others that affect a similar soil.

**POCKET**, in the woollen trade, a word used to denote a larger sort of bag, in which wool is packed up to be sent from one part of the kingdom to another. The pocket contains usually twenty-five hundred weight of wool.

**POEM.** *See* Poetry.

**POETRY**, is that kind of literary composition which is characterized by metrical harmony, and is by its very nature incapable of accurate definition. In the English language, versification depends on the modulation of the accents and the disposition of the pauses, to which is generally added the recurrence of rhyme. The heroic verse consists of ten syllables; its harmony is produced by a certain proportionate distribution of accented and unaccented syllables; and its specific character, whether lively or solemn, soft or slow, is determined by their order and arrangement. When unaccented and accented syllables are regularly alternated, it is called the iambic verse; as,

" A shep|herd's boy,| he seeks |no high|er name,
Led forth| his flock| beside| the sil|ver Thame."

When this order is inverted, and the unaccented is preceded by the accented syllable, it is called a trochaic verse; as,

" Ambi′tion first′ *sprung* from the blest′ abodes."

" *Take*, ho′ly earth′, *all* that′ my soul′ holds dear."

The heroic verse is often diversified by the intervention of an Alexandrine line of twelve syllables, which is liberally used by Dryden: its abuse is pointedly censured by Pope:

" A needless Alexandrine ends the song,
Which, like a wounded snake, drags its slow length along."

It forms a noble termination:

" Teach me to love and to forgive;
Exact my own defects to scan,
What others are to feel, and know myself a man."

The common anapestic verse, of eleven and twelve syllables, in which the accent falls on every third syllable, has generally been appropriated to humorous subjects: when formed into the stanza, it assumes a different character. In the noble war-song of Burns, it is however a strain truly sublime; and in the following passage flows with equal sweetness and pathos:

" 'Tis night, and the landscape is lovely no more:
I mourn, but, ye woodlands, I mourn not for you;
For morn is approaching, your charms to restore,
Perfum'd with fresh fragrance, and glittering with dew.
Nor yet for the ravage of winter I mourn;
Kind Nature the embryo blossom will save:
But when shall spring visit the mouldering urn?
Oh! when shall it dawn on the night of the grave?"

The occurrence of double rhymes is neither very frequent nor very easy in English verse; they are chiefly employed in songs, and are seldom admitted in the higher order of lyrical composition. The following passage from Dryden's Ode on St. Cecilia's Day, affords the most happy example of this kind of verse in our language:

" Softly sweet in Lydian measures,
Soon he sooth'd his soul to pleasures,
War, he sung, is toil and trouble,
Honour but an empty bubble;

> Never ending, still beginning,
> Fighting still, and still destroying:
> If the world be worth thy winning,
> Think, Oh! think it worth enjoying."

Blank verse is composed of lines of ten syllables each, which flow into each other without the intervention of rhymes; its metrical principles reside in its pauses, which should be so judiciously spread as never to suffer the accompaniment of rhyme to be missed. Attempts have been made to enlarge the limits of blank verse, by the introduction of various measures analogous to those employed in rhyme: but to all these efforts the genius of the language discovers an invincible repugnance; vainly are varieties presented to the eye, which are imperceptible to the mind, and untasted by the ear. All rhymeless numbers either flow into good blank verse, or form lines harsh and intractable; a succession of abrupt sounds and mutilated sentences, which by no art of typography, by no imposition of nomenclature, can be made to constitute any metre at all.

*Poetical Classification.*—Pastoral poetry is, above all other, the most limited in its object; and when formed on the model presented to us by Virgil and Theocritus, should be a description of rural scenes and natural feelings, enriched with elegant language, and adorned by the most melodious numbers. The ballad is perhaps the happiest vehicle of pastoral poetry, and there are in our language many ballads of exquisite beauty. The name of Elegy, originally given to funeral monody, was afterwards attached to all plaintive strains. In the Greek and Latin languages it was always written in alternate hexameter and pentameter verse. By the moderns an elegiac stanza was invented, assimilating as nearly as possible with those slow melodious numbers. Many elegies, and perhaps the best, are expressive only of soothing tenderness. Such are those of Tyrtæus and Alcæus, imitated by Tibullus among the Romans, and so happily by our countryman Hammond. The Jesse of Shenstone, which has perhaps never been surpassed, is all pathos. The celebrated elegy of Gray combines every charm of description and sentiment. The elegiac stanza, the monotony of which soon becomes oppressive to the ear, is sometimes happily exchanged for a lighter measure, as in Cowper's Juan Fernandez:

> " Ye winds that have made me your sport,
>   Convey to this desolate shore
> Some cordial endearing report
>   Of a land I shall visit no more.
> My friends do they now and then send
>   A wish or a thought after me?
> Oh! tell me I yet have a friend,
>   Though a friend I am never to see."

The Sonnet represents in an abridged form the ancient elegy, or the same slow stanza is assigned to each, and the sentiments suitable to the one are appropriate to the other. It is always limited to fourteen lines, an artificial character, which should seems to indicate an Oriental extraction. Lyric poetry is versatile and miscellaneous, admitting almost every diversity of measure and of subject. Love and heroism, friendship and devotional sentiment, the triumphs of beauty and the praises of patriotism, are all appropriate to lyrical composition. The soul of enthusiasm, the spirit of philosophy, the voice of sympathy, may all breathe in the same ode. Of our lyrical writers, Dryden is confessedly eminent; Gray is distinguished by the majesty and delicacy of his expression and the correctness of his style; Collins is occasionally animated by a portion of Pindaric spirit. But perhaps there has not appeared in our language a more chaste and pleasing lyric poet than the present professor Smyth, of Cambridge, whose English lyrics breathe throughout all the chaste and soothing strains of genuine poetic enthusiasm. Didactic poetry is minutely preceptive, and professes to convey useful instruction on some particular subject. It is obviously not easy to discover situations in which an author may become a practical teacher, without ceasing to be the poet: and this difficulty is aggravated to the English writer, who has not the resources of the Greek and Roman in the metrical capacities of his language. Satirical poetry is descriptive of men and manners; its aim is to delineate the follies and chastise the vices of the age. Satire is evidently the offspring of polished times; and, unlike other poets, the satirist finds his empire enlarged, and his influence extended, by the progress of society. Satire is either pointed or oblique; eloquence is the soul of the one, ridicule of the other. The one rushes on its object in a torrent of vehemence and declamation; the other pursues a smooth tortuous course, occasionally reflecting to the mind the most momentous truths in the playful aspect of wit and humour. Epic poetry concentrates all that is sublime in action, description, or sentiment. In the structure of a regular epic poem, criticism requires that the fable should be founded in fact, and that fiction should fill the picture of which the outline is traced by truth. In the conduct of the poem, it is exacted that the machinery be subservient to the main design, and that the action should be simple and uniform. There are, however, many poems of the epic or heroic cast, to which criticism has hitherto assigned no name.

It is obvious that the poetical nomenclature established on classical authority, is not sufficiently extensive to include all the compositions of modern times. To what classical school shall we refer the noble ethics of Pope in his Epistles, and of Cowper in his Task? By what name shall we designate the Traveller and the Deserted Village, the Pleasures of Memory, the Pleasures of Hope, neither of which is like the Pleasures of Imagination included in the didactic species, with many other exquisite productions. Originally the drama was a metrical composition, and exhibited all the critical refinements of poetry. The title of poet is still given to every dramatic author, although he should have written in prose, and although the highest dramatic powers may exist without the smallest talent for poetry. The avowed object of the drama is to develop the passions, or to delineate the manners of mankind: tragedy effects the one, and comedy the other. In the English language are many popular dramas of a mixed character, which are written in verse intermingled with prose, and which are called plays. The English drama deviates essentially from that of classical antiquity; and independent of the division of acts and scenes, there is little resemblance between them.

The *curiosa felicitas*, that charm or felicity of expression which Horace so happily exemplified, is one of the most powerful agents in producing poetical emotion. It is the attribute which belongs only to the poet of nature; and is the effusion of some fortunate moments, when consummate judgment has been impelled and inspired by exquisite feeling. The spirit of poetry is not confined to subjects of dignity and importance; it may be perceived in a simple lay, and even in a sportive song. It visited Sappho, as it had sojourned with Pindar; and was as truly the attendant of Theocritus as of Homer. Nor is poetical emotion inspired only by the song of heroes and of gods; it may be awakened even by the strain of playful tenderness, in which the lover celebrates some darling of his mistress. See BLAIR'S *Lectures*, CAMPBELL'S *Philosophy of Rhetoric*, KAIMES'S *Elements of Criticism*.

**POINT**, in Geometry, as defined by Euclid, is a quantity which has no parts, or which is indivisible. Points are the ends or extremities of lines. If a point is supposed to be moved any way, it will, by its motion, describe a line.

**POINT**, is also an iron or steel instrument, used with some variety in several arts. Engravers, etchers, cutters in wood, &c. use points to trace their designs on the copper, wood, stone, &c.

**POINT**, in the Manufactories, is a general term used for all kinds of laces wrought with the needle; such are the point de Venice, point de France, point de Genoa, &c. which are distinguished by the particular economy and arrangement of their points.

**POINT**, among Sailors, a low arm of the shore which projects into the sea, or into a river, beyond the contiguous part of the beach. *To Point a Gun*, to direct it towards any particular object or point. *To Point a Sail*, to affix points through the eyelet holes of the reefs. *See* POINTS.

**POINT** *Blank*, in Gunnery, denotes the shot of a gun levelled horizontally.

**POINTING**, in Naval affairs, is the operation of tapering the end of a rope, and weaving some of its yarns into a kind of mat about the diminished part of it, so as to thrust it more easily through any hole, and prevent it from being untwisted. Thus the end of a reef-line is pointed so, that being stiffer, it may more readily penetrate the eyelet holes of the reef; and the ends of the strands of a cable are occasionally pointed for the greater conveniency of splicing it to another cable, especially when this task is frequently performed. The extremities of the splice of a cable are also pointed, that it may pass with more facility through the hawse-holes. In ships of war, it is customary to point the ends of almost all the ropes.

POINTS, in Naval affairs, flat pieces of braided cordage, tapering from the middle towards each end, whose lengths are nearly double the circumference of the yard, and used to reef the courses and top-sails of a square-rigged vessel; they are fixed to the sails by passing one through every eyelet hole in the reef-bands, and making two knots upon it, one on each side of the sail, to prevent its falling out. *See* REEF.

POINTS of the COMPASS, are the 32 principal points into which the horizon and compass-card are divided. *See* COMPASS.

POINTS, in Heraldry, are the several different parts of an escutcheon, denoting the local positions of any figure.

POISONS, substances which, when applied to living bodies, tend to derange the vital functions and produce death. Some poisons act by their corrosive property, as arsenic and corrossive sublimate; other poisons by being most powerfully astringent; some poisons are acrid, others narcotic and stupefying, which probably have a direct power upon the brain; some destroy animal life by their putrescent qualities.

### POISONS, WITH THEIR SYMPTOMS AND ANTIDOTES.

*Substances.* Concentrated acids: the vitriolic, nitric, muriatic, oxalic, &c.—*Symptoms.* Burning pain, vomiting. Matter thrown up effervesces with chalk, or salt of tartar, or lime, or magnesia.—*Antidotes.* Calcined magnesia: one ounce to a pint of warm or cold water. A glass full to be taken every two minutes, so as to excite vomiting. Soap, or chalk and water; mucilaginous drinks afterwards, such as linseed-tea, or gum arabic and water.

*Substances.* Alkalies: soda, ammonia, lime, &c.—*Symptoms.* Nearly the same as above: the ejected matter does not effervesce with alkalis, but with acids.—*Antidotes.* Vinegar and lemon juice: a spoonful or two in a glass of water very frequently; simply warm water.

*Substances.* Mercurial preparations: corrosive sublimate, &c. &c.—*Symptoms.* Sense of constriction in the throat: matter vomited sometimes mixed with blood.—*Antidotes.* White of eggs; twelve or fifteen eggs beat up and mixed with a quart of cold water. A glass full every three minutes. Milk, gum-water, linseed-tea.

*Substances.* Arsenical preparations: white arsenic, &c. &c.—*Symptoms.* Extreme irritation, pain, sickness, and speedy death, if the poison be not soon counteracted.—*Antidotes.* Warm water with sugar, in large quantities, to excite vomiting. Lime-water, soap and water, pearl-ash and water, mucilaginous drinks.

*Substances.* Preparations of copper, brass, &c. verdigris, halfpence, pins, &c. &c.—*Symptoms.* Nearly the same as from mercury.—*Antidotes.* White of eggs: (see under mercury,) mucilaginous drinks.

*Substances.* Preparations of antimony: emetic tartar, &c.—*Symptoms.* Extreme sickness, with other symptoms of poison, as above stated.—*Antidotes.* Warm water, or sugar and water; afterwards a grain of opium, or fifteen drops of laudanum every quarter of an hour, for two or three times.

*Substance.* Nitre.—*Symptoms.* Obstinate vomiting, sometimes of blood, &c. &c.—*Antidotes.* The same as for arsenic, with the exception of lime-water and alkalies.

*Substance.* Phosphorus.—*Symptoms.* Like mineral acid.—*Antidotes.* Same treatment as last mentioned.

*Substances.* Lead: sugar of lead, goulard extract, &c.—*Symptoms.* Great pain in the stomach, with constriction of the throat, &c. &c.—*Antidotes.* Large doses of Glauber's or Epsom salts, in warm water.

*Substances.* Opium, henbane, hemlock, nux vomica, deadly nightshade, berries, mushrooms, &c. &c.—*Symptoms.* Stupor, desire to vomit, heaviness in the head, dilated pupil of the eye, delirium, and speedy death.—*Antidotes.* Four or five grains of tartar emetic in a glass of water; if this does not succeed, four grains of blue vitroil, as an emetic. Do not give large quantities of water. After the poison has been ejected, give vinegar, lemon juice, or cream of tartar. Strong coffee also is useful.

*Substance.* Poison of the yellow-billed sprat.—*Antidote.* Solution of sugar.

Opium and arsenic, it is well known, are poisons; and, as the effects of these are often fatal before medical aid can be procured, it may not be improper to state briefly the principal antidotes to either. When poison of any kind has been swallowed, the immediate object should always be that of endeavouring to excite vomiting; but much time is often lost by waiting the operations of medical emetics, when the discharge from the stomach might be much more speedily effected by mechanical means. Let, then, the persons who are about the individual who has taken poison, force a feather, or a piece of stick, or any thing that can be immediately procured, down the throat, and thus continue to irritate the parts till vomiting is induced. Emetics are of course to be administered as soon as they can be procured, when the power of swallowing is not suspended. After the contents of the stomach have thus been discharged, it is of consequence to recollect that acids are the best correctives of opium, and alkalies of arsenic. In the one case, that of opium, then, let vinegar or lemon juice, diluted with about an equal quantity of water, be freely and copiously administered: in the other, that of arsenic, let a solution of soap in water be made as strong, and poured down as quickly as possible. This last answers a double purpose, the alkali of the soap acting upon the acid of the arsenic, and thus destroying its virulence; and the oily principle of this material, liberated in some measure from its alkali, seems to lubricate the coat of the stomach, and thus at once to abate the inflammation already excited, and to defend the parts from the further influence of the poison. *See* SYRINGE.

POLACRE, in sea language, a ship with three masts, usually navigated in the Mediterranean; each of the masts are commonly formed of one piece, so that they have neither tops or cross-trees, neither have they any horses to their upper yards, because the men stand upon the top-sail yards to loose or furl the top-gallant-sails, and upon the lower yards to loose, reef, or furl the top-sails, the yards being lowered sufficiently down for that purpose.

POLAR, relating to the pole.

POLAR *Circles.* *See* CIRCLE.

POLE, in Astronomy, one of the extremities of the imaginary axis on which the sphere is supposed to revolve. These two points are each 90 degrees from the equator, that towards the north being called the north pole, and the other the south pole.

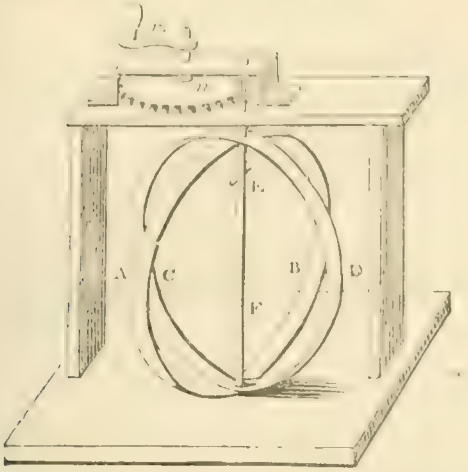
POLE, in Geography, one of the points on which the terraqueous globe turns, each of them being 90 degrees distant from the equator, and are denominated the north or south pole, according as they point towards the north or south points of the heavens. In consequence of the inclination of the terrestrial axis to the plane of the ecliptic, and its parallelism during its annual motion in its orbit, these parts of the world have only one day and one night throughout the year, each continuing for about six months.

It is singular that though the poles have a greater portion of light than any other parts of the globe, yet the name by which they are denoted in most languages, both ancient and modern, is derived from terms signifying darkness and obscurity; but though they really enjoy more light upon the whole than any other parts, yet in consequence of the obliquity with which the rays of the sun fall upon them, and the great length of winter night, the cold is so intense, that those parts of the globe that lie near the poles have never been fully explored, though the attempt has been repeatedly made by the most celebrated navigators.

*Elevation* of the POLE, is an angle subtended between the horizon of any place, and a line drawn from thence to the pole, which is always equal to the latitude of the place.

POLE, in Spherics, a point equally distant from every part of the circumference of a great circle of the sphere; or it is a point 90° distant from the plane of a circle, and in a line called the axis, passing perpendicularly through the centre. The zenith and nadir are the poles of the horizon; and the poles of the equator are the same with those of the sphere.

*Machine for Illustrating the Effects of the Centrifugal Force in Flattening the Poles of the Earth.* The following figure represents this machine, which consists of two flexible circular hoops, A B and C D, crossing each other at right angles, and fixed to the vertical axis E F at its lower extremity, but left loose at the pole or intersection E. If this axis be made to revolve rapidly by means of the winch *m*, and the wheel and pinion *n*, *o*, the middle parts A, B, C, D, will, by their centrifugal force, swell out and strike against the frame; if the pole E, when sinking, is not stopped by means of a pin E fixed in the vertical axis. The hoops, therefore, have a spheroidal form; the equatorial being larger than the polar diameter.



**Poles** of the *Ecliptic*, are two points on the surface of the sphere, 23° 30′ distant from the poles of the world, and 90° distant from every part of the ecliptic.

**Poles**, in Magnetism, are two points of a loadstone corresponding to the poles of the world; the one pointing to the north, the other to the south. *See* Magnetism.

**Pole**, or *Polar Star*, is a star of the second magnitude, the last in the tail of ursa minor.

**Pole**, *Perch* or *Rod*, in Surveying, is a measure containing sixteen feet and a half.

**POLE-AXE**, a sort of hatchet, nearly resembling a battle-axe, having a handle about fifteen inches long, and being furnished with a sharp point, bending downwards from the back of its head. It is principally used on board of ships to cut away the rigging of an adversary who endeavours to board. They have also been sometimes employed in boarding an enemy whose hull was more lofty than that of the boarders, by driving the points into her side, one above another, and thereby forming a kind of scaling-ladder; whence they are sometimes called *boarding-axes*.

**POLECAT**, in Zoölogy, the name by which a creature of the weasel kind is known. It is sometimes also called *Fitchet*, and is remarkable for its stinking smell. This animal proves exceedingly destructive to rabbits when it finds a lodgment in warrens; many contrivances are therefore made for its destruction.

**POLEMOSCOPE**, in Optics, a kind of reflecting perspective glass invented by Hevellus, who commends it as useful in sieges, &c. for discovering what the enemy is doing, while the spectator lies hid behind an obstacle.

**POLES**, *Under Bare*, the situation of a ship at sea, when all her sails are furled. *See* Scudding and Trying.

**POLICY** of Assurance, the deed or instrument by which a contract of assurance is effected.

**POLISHER**, or *Burnisher*, among Mechanics, an instrument for polishing and burnishing things proper to take a polish.

**POLISHING**, in general, the operation of giving a gloss or lustre to certain substances, as metal, glass, &c. The operation of polishing optic glasses, after being perfectly ground, is one of the most difficult points of the whole process. Before the polishing is begun, it is proper to stretch an even well-wrought piece of linen over the tool, dusting upon it some very fine tripoli. Then taking the glass in your hand, run it round forty or fifty times upon the tool, to take off the roughness of the glass about the border of it. This cloth is then to be removed, and the glass to be polished upon the naked tool, with a compound powder made of four parts tripoli mixed with one of fine blue vitriol; six or eight grains of which mixture are sufficient for a glass five inches broad. This powder must be wetted with eight or ten drops of clear vinegar, in the middle of the tool; being first mixed and softened thoroughly, with a very fine small mullet. Then, with a nice brush, having spread this mixture thinly and equably upon the tool, take some very fine tripoli, and strew it thinly and equably upon the tool so prepared, after which, take the glass to be polished, wiped very clean, and apply it on the tool, and move it gently twice or thrice in a straight line backwards and forwards; then take it off, and observe whether the marks of the tripoli, sticking to the glass, are equably spread over the whole surface; if not, it is a sign that either the tool or glass is too warm, in which case you must wait a while and try again, till you find the glass takes the tripoli every where alike.

Sir Isaac Newton no where expressly describes his method of polishing optical glasses; but his method of polishing reflecting metals, he thus describes in his Optics. He had two round copper plates, each six inches in diameter, the one convex, the other concave, ground very true to one another. On the convex one he ground the object-metal, or concave, which was to be polished, till it had taken the figure of the convex, and was ready for a polish. He then pitched over the convex very thinly, by dropping melted pitch upon it, and warming it to keep the pitch soft, whilst he ground it with the concave copper wetted, to make it spread evenly all over the convex, till it was no thicker than a sixpence; and after the convex was cold he ground it again, to give it as true a figure as possible. He then ground it with very fine putty, till it made no noise; and then upon the pitch he ground the object-metal with a brisk motion, for two or three minutes; when laying fresh putty upon the pitch, he ground it again till it had done making a noise, and afterwards ground the object-metal upon the pitch as before; and this operation he repeated till the metal was perfectly polished. *See* Lens and Specula.

The Parisians have now introduced an entirely new mode of polishing, which is called *plaque*, and is to wood precisely what plating is to metal. The wood, by some process, is made to resemble marble, and has all the beauty of that article, with much of its solidity. It is even asserted by persons who have made trial of the new mode, that, with the exception of the actual strength of marble, it has no qualities superior to the imitation, upon which water may be spilled without staining, and it will resist scratching in the same degree as marble.

*Method used in Germany for Varnishing Wood.*—In the first place, the Germans are careful to join their wood very neatly, and to make the surface very smooth, because if the varnish brings out the beauty of the wood, it does the same by the defects. When the wood is once well polished, they prepare the varnish. For this purpose they reduce to a powder some of the purest shell lac, that is to say, very transparent, and dissolve it in well-rectified spirits of wine; they add, in a retort, double the quantity of alcohol to the lac employed, and expose it to a heat of about fifty degrees Reaumur. They are careful to agitate the mixture every three hours, until the varnish has acquired the suitable consistence; if it does not appear of a sufficient consistence, they add a little more pulverized lac; if on the contrary it is too thick, they mix a little more alcohol, being careful to agitate the mixture until it is of the right thickness. This varnish has no peculiar quality, except that it contains no turpentine, nor any other body that renders the varnish gluey, and liable to crack. They apply the varnish with a piece of fine linen, which is formed into a sort of pallet. The workman is previously provided with a mixture of two parts of varnish to one of olive oil, in which he soaks the linen, and then rubs it over the surface of the wood with great force, and pressing very hard upon it, but always in the direction of the fibres of the wood. He begins afresh by moistening the wood again, until the whole surface of the wood is covered with a slight coat of varnish. When the wood is well moistened with the varnish, they leave it to dry, which it does very quickly, and they then apply a second coat, a third, and even a fourth if necessary. When the varnish is perfectly dry and hard, they give it the lustre in the following manner:—They steep a piece of fine linen in a mixture of olive oil and tripoli reduced to powder, and rub the wood hard with it until the varnish has acquired the proper degree of brilliancy. Then, to give it the last polish, they rub it with a piece of very soft linen, or very fine soft leather.

This varnish may also be applied with a brush, on bodies that do not offer an even surface, only it must then be made thinner, by adding a greater proportion of alcohol. It may afterwards be polished in the manner above described. When it is applied to bodies of great surface, it is essential that the varnish be made as thin as for bodies in relief, because as it dries quickly, the edges of the parts that are first laid on would acquire a degree of thickness which could not be reduced in the polishing. Lastly, articles that are turned in wood may be varnished and polished in the same manner even in the lathe. The only inconvenience attending this varnish is, that it gives the wood a brownish colour, which is no inconvenience where a deep colour is desired; and for which reason, it is much used in varnishing mahogany and the walnut and cherry tree woods. But when the wood is to be kept of a light colour, the varnish is made in the same manner, only, instead of the lac, they use copal gum dissolved in the alcohol, adding to it sometimes a little camphor or ether. This varnish may be applied with success to many different sorts of wood.

Some of the Vienna makers dissolve the copal by exposing it to the action of the vapour of alcohol, and sometimes they colour the copal varnish, which is naturally colourless, with any tint they may wish to give it; and they do not seem to use any spirits of turpentine to dissolve the copal. By this method of applying varnish to wood, it penetrates so completely into the grain, that it is almost impossible to crack it. So that when scraped, even with a sharp instrument, if the traces be not very deep, the polish may be restored by hard rubbing with a soft piece of linen. The gluey varnishes have not this advantage, since they do not penetrate so deep into the substance of the wood, and a scratch will take them almost clean off, in such a manner that no friction will restore the polish.

**POLITICAL** ARITHMETIC, calculations relating to the wealth of nations. Political arithmetic does not determine in what natural wealth truly consists, but estimates the value of whatever passes under this name, and distinguishes the proportions in which the component articles may be applied to purposes conducive to the safety or prosperity of the community.

POLITICAL *Economy*, is the science which treats of the wealth nations. Its object is to ascertain, in the first place, wherein wealth consists, and then to explain the causes of its production, and the principles on which it is distributed through the different orders of society. It likewise endeavours to point out the tendency which any political regulations may have to favour or to injure the productions, or most advantageous distribution of wealth. Such is its peculiar object; and consequently, though writers on political economy may frequently treat on the more important topics of national security, freedom, and happiness, they are then passing the strict limits of their science.

**POLL**, a word used in ancient writing for the head.

POLL *Money*, a capitation or tax, imposed by the authority of parliament on the head or person either of all indifferently, or according to some known mark of distinction.

**POLLUX**, in Astronomy, one of the Twins in the constellation Gemini; also a fixed star of the second magnitude in that constellation. *See* GEMINI

**POLYACOUSTIC**, any thing that multiplies sound.

**POLYGAMY**, the plurality of wives or husbands, in the possession of one man or woman at the same time.

**POLYGLOTT**, among divines and critics, chiefly denotes a bible printed in several languages.

**POLYGON**, in Fortification, denotes the figure of a town, or other fortress.

*Line of* POLYGONS, on the French sectors, is a line containing the homologous sides of the first nine regular polygons inscribed in the same circle; that is, from an equilateral triangle to a dodecagon.

**POLYGON**, in Geometry, a multilateral figure, or a figure whose perimeter consists of more than four sides, and consequently having more than four angles. If the angles be all equal among themselves, the polygon is said to be a regular one; otherwise it is irregular. Polygons also take particular names according to the number of their sides; thus a polygon of

3 sides is called a trigon,
4 sides is called a tetragon,
5 sides is called a pentagon,
6 sides is called a hexagon, &c.

and a circle may be considered as a polygon of an infinite number of small sides, or as the limits of the polygons. Polygons have various properties, as below:—

1. Every polygon may be divided into as many triangles as it has sides.

2. The angles of any polygon taken together, make twice as many right angles, wanting 4, as the figure hath sides; which property, as well as the former, belongs to both regular and irregular polygons.

3. Every regular polygon may be either inscribed in a circle, or described about it; which is not necessarily the case if the polygons be irregular. But an equilateral figure inscribed in a circle is always equiangular; though an equiangular figure inscribed in a circle is not always equilateral, but only when the number of sides is odd. For if the sides be of an even number, then they may either be all equal, or else half of them may be equal and the other half equal to each other, but different from the former half, the equals being placed alternately.

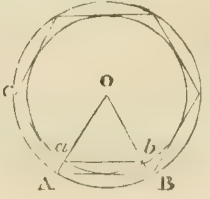
4. Every polygon, circumscribed about a circle, is equal to a right-angled triangle, of which one leg is the radius of the circle, and the other the perimeter or sum of all the sides of the polygon. Or the polygon is equal to half the rectangle under its perimeter and the radius of its inscribed circle, or the perpendicular from its centre upon one side of the polygon.

Hence the area of a circle being less than that of its circumscribing polygon, and greater than that of its inscribed polygon, the circle is the limit of the inscribed and circumscribed polygons: in like manner, the circumference of the circle is the limit between the perimeters of the said polygons. *See* CIRCLE.

5. The following table exhibits the angles and areas of all the polygons, up to the dodecagon, *viz.* the angle at the centre, the angle of the polygon, and the area of the polygon when each side is 1.

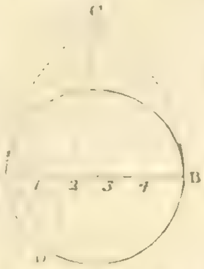
| No. of Sides. | Name of Polygon. | Ang. F. at Cent. | Ang. C. of Polygon. | Area. |
|---|---|---|---|---|
| 3 | Trigon,.......... | 120° | 60° | 0·4330127 |
| 4 | Tetragon, ....... | 90 | 90 | 1·0000000 |
| 5 | Pentagon,....... | 72 | 108 | 1·7204774 |
| 6 | Hexagon, ....... | 60 | 120 | 2 5980762 |
| 7 | Heptagon, ...... | $51\frac{3}{7}$ | $128\frac{4}{7}$ | 3·6339124 |
| 8 | Octagon, ........ | 45 | 135 | 4·8284271 |
| 9 | Nonagon, ....... | 40 | 140 | 6·1818242 |
| 10 | Decagon,........ | 36 | 144 | 7·6942088 |
| 11 | Undecagon,...... | $32\frac{8}{11}$ | $147\frac{3}{11}$ | 9 3656399 |
| 12 | Dodecagon, ..... | 30 | 150 | 11·1961524 |

Therefore to find the area of any regular polygon not exceeding 12 sides, square the side, and multiply that square by the corresponding tabular number in the preceding table. Or generally, if $s$ represent the length of one of the equal sides, and $n$ the number of them; then $s^2 \times \frac{n}{4}$ tang. $\left(\frac{90\,n - 180}{n}\right) =$ area of the polygon.



*To inscribe a Polygon within, or to circumscribe a Polygon about a given Circle.*—Bisect two of the angles of the given polygon A and B by the right lines A O, B O; and from the point O, where they meet, with the radius A O, describe a circle which will circumscribe the polygon. Next, to circumscribe a polygon divide 360 by the number of sides required to find the angle

A O B; which set off from the centre O, and draw the line A B, on which construct the polygon as in the following problem. 2. On a given line to describe any given regular polygon. Find the angle of the polygon in the table, and at A set off an angle equal thereto; then drawing C A = A B, through the points C A B, describe a circle, and in this applying the given right line as often as you can, the polygon will be described.



*Otherwise. To inscribe a Polygon in a Circle.*—Draw the diameter A B, which divide into as many equal parts as the figure has sides. From the points A, B, as centres with the radius A B, describe arcs crossing each other in C. From the point C, through the second division of the diameters, draw the line C D. Join the points A, D, and the line A D will be the side of the polygon required.

*Note.*—In this construction A D is the side of a pentagon.

Another method, something more accurate, is by erecting a perpendicular from the centre of such a length that the part without the circle shall be equal to ¾ of that within, and drawing a line from its extremity through the second division as before.

In the preceding part of the article it is observed, that any regular polygon may be inscribed in, or circumscribed about, a circle: but this must be understood under certain modifications; all that is meant is, that there is nothing in the nature of the problem to render it impossible; and not that any polygon may be geometrically inscribed. In fact, the number of polygons that admit of a geometrical construction is very limited, *viz.* the equilateral triangle, the square and pentagon, and those figures whose number of sides are some multiples of these; to which Gauss has lately added the 17-sided polygon, and its multiples, and some others, *viz.* all those polygons whose number of sides is a prime, and of the form $2^m + 1$.

POLYGONAL *Numbers*, are those that are formed of the sums of different and independent arithmetical series, and are termed *Natural, Triangular, Quadrangular, Pentagonal, Hexagonal*, &c. *Numbers*; according to the series from which they generated.

*Lineal*, or *Natural Numbers*, are formed from the successive sums of a series of units; thus,

| | |
|---|---|
| Units ........................ | 1, 1, 1, 1, 1, 1, &c. |
| Nat. num. .................... | 1, 2, 3, 4, 5, 6, &c. |

*Triangular Numbers*, are the successive sums of an arithmetical series, beginning with unity, the common difference of which is 1; thus,

| | |
|---|---|
| Arith. series ........... | 1, 2, 3, 4, 5, 6, 7, &c. |
| Trian. num............. | 1, 3, 6, 10, 15, 21, 28, &c. |

*Quadrangular*, or *Square Numbers*, are the successive sums of an arithmetical progression, beginning with unity, the common difference of which is 2; thus,

| | |
|---|---|
| Arith. series............ | 1, 3, 5, 7, 9, 11, 13, &c. |
| Quad. or squa........... | 1, 4, 9, 16, 25, 36, 49, &c. |

*Pentagonal Numbers*, are the sums of an arithmetical series, the common difference of which is 3; thus,

| | |
|---|---|
| Arith. series .......... | 1, 4, 7, 10, 13, 16, 19, &c. |
| Pentagonals .......... | 1, 5, 12, 22, 35, 51, 70, &c. |

And, universally, the *$m$-gonal Series of Numbers*, is formed from the successive sums of an arithmetical progression, beginning with unity, the common difference of which is $m - 2$.

POLYGONOMETRY, is an extension of the science of trigonometry, having the same reference to polygons in general, as trigonometry has to triangles in particular. We owe this extension of the rules of trigonometry to L'Huiller, who published a treatise on this subject at Geneva, in 1789; which, with the exception of a chapter in the third volume of Dr. Hutton's "Course of Mathematics," is, we believe, the only work on polygonometry at present before the public.

POLYGONUM BISTORTA. (*Bistort.*) *The Roots.* All the parts of the bistort have a rough austere taste, particularly the root, which is one of the strongest of the vegetable astringents. It is employed in all kinds of immoderate hæmorrhages and other fluxes, both internally and externally, where astringency is the only intention. It is certainly a very powerful styptic, and is to be looked on simply as such; the sudorific, antipestilential, and other like virtues attributed to it, it has no other claim to, than in consequence of this property, and of the antiseptic power which it has in common with other vegetable styptics. The largest dose of the root in powder is one dram.

POLYGONUM *Fagopyrum.* (*Buck Wheat.*) This is usually sown in places where pheasants are bred, as the seed is the best food for those birds; it is also useful for poultry and hogs. We have eaten bread and cakes made of the flower, which are also very palatable. Two bushels are usually sown per acre. The season is May; and it is often sown on foul land in the summer, as it grows very thick on the land, and helps to clean it by smothering all the weeds. The crop does not stand on the ground more than ten or twelve weeks.

POLYGRAM, a figure consisting of many lines.

POLYHEDRON, or POLYEDRON, a body or solid contained by many rectilinear planes or sides. When the sides of the polyhedron are regular polygons, all similar and equal, then the polyhedron becomes a regular body, and may be inscribed in a sphere; that is, a sphere may be described about it, so that its surface shall touch all the angles or corners of the solid. There are but five of these regular bodies, *viz.* the *tetrahedron*, the *hexahedron* or cube, the *octahedron*, the *dodecahedron*, and the *icosahedron.*

POLYHEDRON, *Gnomonical*, is a stone with several faces, on which are projected various kinds of dials. Of this sort, that in the Privy Garden, London, now gone to ruin, was esteemed the finest in the world.

POLYNEMUS, the *Polyneme*, in Natural History, a genus of fishes of the order abdominales. Shaw enumerates ten species; Gmelin only four. The Paradise polyneme, or mango fish, inhabits the Indian and American seas, and is thirteen inches long, elegantly shaped, and with thoracic filaments frequently far larger than the body; its colour is yellow. At Calcutta it is in the highest estimation for the table. The gray polyneme abounds on the Malabar coast, and has five filaments on each side, but all rather short. It is sometimes four feet long, and is in some parts of India denominated the royal fish, from its extraordinary excellence. The polyneme of the Nile is, both in form and taste, superior to every other fish in the rivers which flow into the Mediterranean or Atlantic seas. It is covered with scales resembling the most brilliant silver spangles, and is of the weight of thirty, in some instances of seventy pounds. It is a native of the Nile, and Bruce has minutely detailed the process adopted by the Egyptians for taking it, by a cake of flour, dates, and other ingredients, with a considerable number of hooks concealed in it; but attached to a string held by the fisherman, who floats on the stream upon a blown-up goat's skin, in order to sink this mass, and then returns to the bank. He then fixes the line to some tree, connecting it with a bell, the sounds of which give him notice of the success of his experiment, being produced by the twitchings and pulls of the fish.

POLYNOMIAL, in Algebra, a quantity consisting of many terms.

POLYPUS, the popular name for those fresh water insects which class under the genus of hydra, of the order of vermes zoophytæ.

POLYSCOPE, or POLYHEDRON, in Optics, a multiplying-glass, or one which represents a single object to the eye, as if there were many. It consists of several plane surfaces, disposed under a convex form, through each of which the object is seen.

POMELION, a name given by seamen to the cascabel, or hindermost knob of a cannon.

PONCHES, small bulk heads made in the hold to stow corn, goods, &c.

PONDERABILITY, a contingent property of bodies. Every substance within the sphere of observation is found to possess weight, or a disposition to gravitate towards the centre of the earth. But to constitute gravity, it is not required that a body should invariably fall to the ground. Smoke ascends in the atmosphere, and a lump of lead rises in a tub of mercury, from the same cause that a pine tree plunged into a lake mounts again to the surface. Withdraw the air, the mercury, and the water, which supported those comparatively lighter substances, and the smoke, the lead, and the timber, will immediately descend. Pour mercury over a smooth piece of cork, applied to the bottom of a glass, and it will remain in the same situation, while an iron ball can be set to float on the liquid metal. The order of nature might here seem to be reversed. But, since mercury does not insinuate itself through a very narrow interstice, it merely rests on the upper side, without pressing against the under side, of the cork. If *levity*, however, as the schoolmen asserted, had been a real property belonging to certain bodies, the smoke and the cork would, in every instance, have occupied the lower stations. But the weight of a body is not the same in all places and situations. A lump of lead, which weighs a thousand pounds at the surface of our globe, would lose two pounds, as indicated by a spiral spring, if carried to the top of a mountain four miles high; and, if it could be conveyed as deep into the bowels of the earth, it would lose one pound. The same mass transported from London to the Pole, would gain the addition of 2 lbs. 769 decim. parts, (nearly 3 lbs.); but if taken to the Equator, it would suffer a loss of 4¼ lbs. The variable, and therefore contingent, weight of bodies, is only the gradation of that mutual and universal tendency, diminishing as the square of the distance, which retains the moon in her orbit, and upholds the circulation of the whole system of planets around the sun. The gravitation even of small masses towards each other, such as balls of lead separated only by the interval of a few inches, has been detected by delicate experiment, and reduced to rigorous calculation. But when the approximation is closer, this force acquires a modified character, and passes into cohesion. Thus, if two leaden bullets have a little portion of the surface of each pared clean, and be then pressed together with a slight twist, they will cohere firmly into one mass. In the same manner, gold or silver foliage, and other ornaments, struck with a heavy hammer into the surface of polished iron or steel, become permanently united. Within other limits, the tendency to mutual approach is changed into an opposite quality. Thus, drops of rain or dew, run along the smooth and glossy surface of a cabbage leaf without spreading. If the dust of the lycopodium, or club fern, or even fine pounded rosin, be strewed on water contained in a glass, any smooth rounded piece of soft wood will float upon it, or may be immersed in the liquid, without being wetted, the powder preventing, by its repulsion, all contact of the water. A fine needle, laid on the surface of water, makes a dimple in which it swims. On the same principle, the slender limbs of insects, and the minute down which covers their wings, protects them from the penetration of humidity. If the hand be rubbed with linseed oil, it may be plunged with impunity for a few seconds in boiling water, the oil repelling the water, and consequently checking the communication of heat. The application of palm soap to the skin is still more effectual.

It thus appears that bodies are indefinitely porous, compressible without limits, and capable of assuming all variety of forms. How different is the constitution of ice, of water, and of steam? Consider what mutable aspects mercury exhibits. Beginning at a low degree of cold, and ascending through the gradations of heat, we find it a friable solid, next a shining liquid, then a penetrating vapour, and lastly, a fine red powder. A bright ductile piece of metal passes successively into an earthy oxide and pellucid glass. Charcoal is precisely of the same nature as the diamond; yet what a contrast between the dingy appearance of the one, and the dazzling lustre of the other? How variously are substances transformed by the operations of art? The skins of animals become changed into parchment and different kinds of leather, and its shreds into glue. The animal fibres are converted into matting, cordage, and linen cloth; and the rags, again, reduced to a pulp, and manufactured into paper.

How diversified appear the compounds of the farinaceous substances? By a distinct operation, the same grain produces gruel, bread, biscuit, starch, and a hard pellucid concretion resembling mother-of-pearl. But the plastic powers displayed in the process of vegetation and animal life, infinitely surpass the resources of art. Many plants are fed by water and air alone, and consequently these fluids are capable of being transformed into all the various products. In short, nature exhibits only a chain of endless metamorphoses: the substance or material remains unchanged, but its form undergoes continual mutations.

The properties of bodies result from those of their component particles. At certain mutual distances they remain quiescent; but, at other distances, they shew a disposition either to approach or to recede. Such opposite tendencies are commonly referred to the principles of attraction and repulsion. But all those diversified effects may be comprehended under a general law, which connects the mutual action of particles with their distance. In the language of modern analysis, the corpuscular energy is always some *function* of the distance; and it may be represented by an extended curve, of which the abscissæ mark the distances, and their ordinates express the corresponding forces. Fig. 1, exhibits this curve of primordial action; in which A denotes an action or ultimate particle, and B, C, D, E, &c. the successive positions of another particle, the perpendiculars CM, EN, GO, IP, LQ, &c. representing their mutual action attractive between B and D, F and H, K and X, when above the axis AX, and repulsive between D and F, H and K, below it. The final branch of the curve must gradually assimilate itself to the law of universal gravitation. But the primary branch of the curve must, in like manner, continually approach AY, the perpendicular to the axis; and since no pressure or impulsion can ever accomplish the penetration of matter, it follows, from the principles of Dynamics, that the space included between the curve and that asymptote must be finite. Where the curve repeatedly crosses the axis, are so many quiescent positions, B, D, F, H, K, &c. in any one of which a particle would continue *in equilibrio*. But this equilibrium is of two kinds, the *stable* or the *instable*; the former easily recovering itself from any slight displacement, and the latter, when once disturbed, being irremediably dissolved. If the curve in its progress cross the axis from the side of repulsion to that of attraction, its intersection will evidently be a point of stability; for if a particle be pushed inwards, it will then be repelled back again; and if it be pulled outwards, it will experience an attractive force, which will recall it to its first position. But if the curve pass from attraction to repulsion, its intersection with the axis is a point of instable equilibrium; for, in proportion as a particle is pressed inwards, it will be pulled forcibly from its position; and if it be drawn outwards, the repulsion, now conspiring, will bear it along with accumulating power. Thus, B, F, and K, the transitions from repulsion to attraction, are points of stability; but D and H, the opposite transitions, are points of instability.

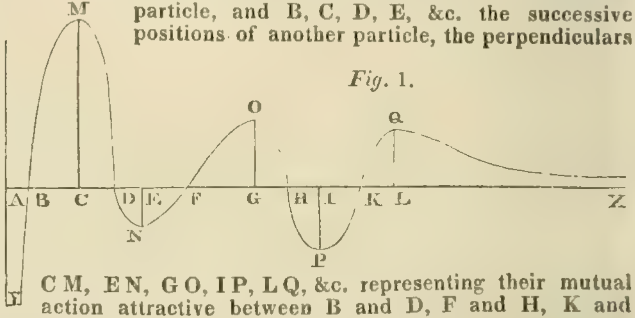


*Fig.* 1.

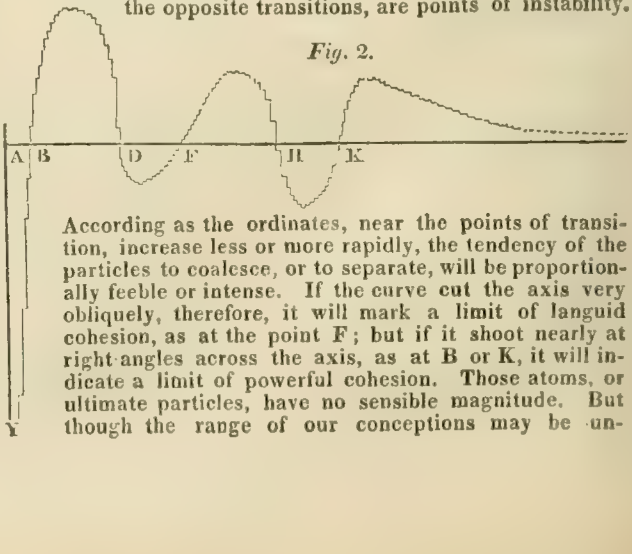


*Fig.* 2.

According as the ordinates, near the points of transition, increase less or more rapidly, the tendency of the particles to coalesce, or to separate, will be proportionally feeble or intense. If the curve cut the axis very obliquely, therefore, it will mark a limit of languid cohesion, as at the point F; but if it shoot nearly at right angles across the axis, as at B or K, it will indicate a limit of powerful cohesion. Those atoms, or ultimate particles, have no sensible magnitude. But though the range of our conceptions may be unbounded, every thing in the material world appears to be distinct and determinate. Experience indeed informs us, to what astonishing degree matter can be attenuated, but philosophy descries the existence of certain fixed or impassable limits, at which the capability of farther subdivision utterly ceases. The primordial line of action is hence a physical, and not a mathematical curve; or it is not strictly incurvated at every point, but proceeds by successive minute deflections, corresponding to the breadth of the elementary particles. Such a modification of the curve is represented by fig. 2; being a serrated line, whose gradations answer to the successive stages of corpuscular action. Continuous shades, indeed, exist only in our modes of conception, and nature exhibits always individual objects, and advances by finite steps. The material world is hence reducible to atoms, actuated by forces depending merely on their mutual distances. From such simple elements,—the different arrangements of the particles,—and their multiplied interior combinations, this sublime scene of the universe derives all its magnificence and splendour.

**PONTON**, or **Pontoon**, in War, denotes a little floating bridge made of boats and planks. The ponton is a machine consisting of two vessels at a little distance, joined by beams, with planks laid across for the passage of the cavalry, the cannon, infantry, &c. over a river, or an arm of the sea, &c. *See* BRIDGE.

**PONTOON**, in Naval affairs, a large low flat vessel, nearly resembling a barge of burden, and furnished with cranes, capstans, tackles, and other machinery necessary for careening ships; these are principally used in the Mediterranean, but very seldom in the northern parts of England.

**Pontoon**, or *Ponton*, a kind of flat-bottomed boat, whose carcase of wood is lined within and without with tin. They are generally twenty-one feet long, five feet broad, and two feet one inch and a half deep within.

**POOP**, the highest and aftmost deck of a ship. *To have the Wind in Poop*, is to have it behind or favourable.

**Poop** *Royal*, a short deck, or platform, placed over the aftmost part of the poop in the largest of the French and Spanish men of war, and serving as a cabin for their masters and pilots. This is usually called the top-gallant-poop by our shipwrights.

**POOPING**, the shock of a high and heavy sea upon the stern or quarter of a ship, when she scuds before the wind in a tempest. This circumstance is extremely dangerous to the vessel, which is thereby exposed to the risk of having her whole stern beat in, by which she would be laid open to the entrance of the sea, and most probably founder.

**Pooping**, implies also the action of one ship running her stem against another's stern.

**POOR LAWS.** Of the general outline of this most enormous, and almost ineffectual burden on the people, much has been said in the excellent treatise of Mr. Colquhoun. The 43 of Eliz. c. 2, is the foundation of all that is good in the poor-laws; making provision for finding work for the industrious and able; for compelling the idle and able to labour; and for affording relief to the diseased and impotent; and the 13, 14, Charles II. c. 12, is the foundation of all that is evil, by forming the system of settlements and removals; a system establishing oppression, litigation, and expense, and which has been made more oppressive, and more productive of litigation and expense, by every subsequent statute, till the statute of the 35th of his late Majesty; which, by forbidding removals in case the paupers is not absolutely chargeable, has remedied more than half the evils occasioned by the former laws.

*Overseers.*—The churchwardens of every parish, with two, or three, or four substantial householders, according to the size of the parish, to be nominated in Easter week, or within a month after, under the hands or seals of two or more neighbouring justices, and who shall be called overseers of the poor. 43 Eliz. c. 2. s. 1. Where there are no churchwardens, the whole power is vested in the overseers, 17 Geo. II. c. 38, s. 15. Overseer dying or becoming incapable of acting, two justices may appoint another. *Ibid.* s. 3. If any person shall find himself aggrieved by any act of the justices, appeal to the sessions whose determination shall be final. *Ibid.* s. 6. Where there is no nomination of overseers, penalty 5*l.* on every justice of the division. Recovery by distress from the sessions, to be levied by the churchwardens and overseers. 43 Elizabeth, c. 2, s. 10. Parish officers with the consent of two justices shall set children to work, whose parents cannot maintain them, and all persons married or single who cannot maintain themselves, and have no regular trade or calling; and one justice may send persons to the house of correction who will not work; and the parish officers, not having an excuse, to be allowed by two justices, shall meet once in a month at least, in the church, on a Sunday after evening service, to consult. Penalty 20*s.* Recovery by distress, and, in default, commitment till paid.—Application to two justices by the poor for an appeal to the sessions. Ibid. s. 1, 2. 6, 11.—Overseers, within four days of the end of their year, shall account to two justices of all sums received and paid, and pay over what remains to their successors; who in default may levy it by distress, under warrant of two justices; who, in default of distress, may commit till paid. Ibid. s. 2, 4.—Every parish officer neglecting to obey the regulations of the above act, penalty from 40*s.* to 5*l.* Recovery by distress. Application to two justices by the poor. 17 George II. c. 38, s. 14.—Parish officer neglecting his duty, or disobeying the warrant of a justice, penalty 40s. to be recovered by distress, and, in default, commitment not exceeding ten days, before two justices of the poor for an appeal to the sessions, giving ten days notice. 33 George III. c. 55, s. 1, 2.

*Rate.*—Parish officers shall raise by a rate on all the inhabitants, a stock of flax, &c. to set the poor to work, and sums for the relief of the old and lame who are not able to work, and for apprenticing poor children. Rate to be made by consent of two justices. 43 Elizabeth c. 2, s. 1.—Parish officers shall cause notice to be given publicly in the church, of such consent of the justices, the next Sunday; and no rate shall be collected till such notice is given. 17 George II. c. 3, s. 1. They shall permit the inhabitants to inspect such rates at all seasonable hours, on payment of 1*s.*; and give copies, on payment of 6*d.* for every twenty-four names. Penalty 20*s.* Application to the party aggrieved. Ibid. s. 2, 3.—Persons aggrieved by assessment appeal to the sessions. 17 George II. c. 38, s. 4. Goods of persons refusing to pay may be distrained in any part of the county; and of any other county, on oath made before a justice of such other county, which oath shall be certified in the warrant. Appeal to the sessions of the county where the assessment was made. Ibid. s. 7. If two justices perceive that the inhabitants of any parish are not able to levy money sufficient for the relief of the poor, they shall assess any neighbouring parishes within the hundred, in aid; and if the hundred be not of sufficient ability, then any parishes within the county, 43 Elizabeth, c, 2, s. 3. Father, grandfather, mother, or grand mother, of persons wanting relief, shall maintain them; penalty 20*s.* per month. Recovered by distress, and in default commitment till paid. Application to two justices by the poor. Ibid. s. 2. 11. Fathers leaving their wives and children, and mothers their children chargeable to the parish, having ability to maintain them, the parish officers, where such are left, may, by warrant of two justices, seize so much of the goods and chattels, or receive so much of the annual rent as such justices shall appoint, to reimburse the parish: and such order to be confirmed by the sessions. 5 George I. c. 8, s. 1. Parish officers, with consent of the lord of the manor, may, by order of two justices, erect cottages on waste lands, for the poor. 43 Elizabeth, c. 2, s. 5. They may also, with consent of two justices, set up trades, &c. for the employment of the poor. 3 Charles II. c. 4, s. 22.

*Relief.*—Parish officers, with consent of the majority of the inhabitants, may contract with any person for the lodging, keeping, maintaining, and employing the poor; and persons refusing such relief are not entitled to any other. 9 George I. c 7, s. 4. The abominable oppression of this execrable law has, however, been removed by another humane statute of the late reign; for by 36 George III. c. 25, s. 1, 2, 3, it is enacted, that it shall be lawful for the parish officers, with the approbation of one justice, in writing, to relieve any industrious person at his own habitation, under certain circumstances of temporary illness, or distress; and one justice may order such relief for any time not exceeding one month, provided the cause be written on the back of the order, which the parish officers are bound to obey; and two justices may continue such orders from time to time, each period in succession not being more than one month. A justice or a medical man, or clergyman by warrant of a justice, may visit workhouses, and examine the state of them, and hear complaints, and certify to the sessions; and if there should be any infectious disorder, the visiting justice shall apply to another justice, or any other person visiting, to two justices; which two justices shall order such regulations as they deem necessary till the next sessions. 30 George III. c. 49, s. 1, 2. Names of persons receiving parish relief to be entered in a book. 3 William, c. 11, s. 11. And no other person to be relieved but by order of a justice. Ibid. No relief to be ordered by a justice unless for a reasonable cause, proved on oath, and unless the pauper shall have first applied to a parish officer or a vestry, nor before the justice shall have summoned the parish officers. 9 George I. 6, 7, s. 1. The name of such persons to be entered with the others; and no parish officer, except on sudden emergency, shall bring any charge on the parish for persons not registered. Penalty 5l. Recovered by distress. Application to two justices by the poor. Ibid. s. 2.

*Settlements.*—The general heads on which settlements are founded are birth, apprenticeship, service, serving offices, renting 10l. per annum, marriage, and estate. A house at not less than 10l. per annum, for at least one whole year, for which term rent and taxes must be paid and occupied.

1. *Birth.*—Children *prima facie*, whether bastards or legitimate, are settled where born; but with respect to bastards, if a woman goes collusively to be delivered in another parish, the child gains no settlement there. Bastards born during an order of removal, or the suspension of it, belong to the mother's parish. 35 George III. c. 101, s. 6. And so of bastards born in vagrancy. 17 George II. c. 5, s. 25. And so if born in houses of industry in incorporated districts. 20 George III. c. 36. Or in friendly societies. 33 George III. c. 54, s. 25. Or in lying-in hospitals. 13 George III. c. 82. Legitimate children are settled as their parents, till old enough to gain a settlement of their own, the earliest period of which is seven years: at which age, by 6 Elizabeth, c. 5, s. 12, a child may be apprenticed to a person using the seas; and by 17 George II. c. 5, justices may bind the child of a vagrant of the same age; and any apprentice gains a settlement in a place where he has resided as such for forty days.

2. *Apprenticeship.*—The time required to gain a settlement has just been mentioned. The apprentice must be legally bound, except that the contract not being indented, which is fatal in every other case, is not in this. 31 George II. c. 11.

3. *Service.*—Unmarried persons without children, hired and serving for a year, gains a settlement. 3 William, c. 11. But must continue a whole year in such service. 8, 9 William c. 30. Serving a certificated member of a benefit society no settlement. 33 George III. c. 54, s. 24. Forty days' residence in the place necessary, but they need not be all together. Where the last forty days are in different places, settlement where the servant slept the last night. General hiring deemed hiring for a year. Hiring for a year, with liberty to be absent at harvest, sheep-shearing, &c. gains no settlement; but to serve a month in the militia does. Hiring for one day short of a year, no settlement. Serving for three hundred and sixty-five days, if leap year, no settlement. Hiring at so much per week, conditionally to part at a month's warning, deemed a general hiring; and as such, a hiring for a year.

4. *Serving Offices.*—Persons coming to inhabit a place, and executing any annual and public office for a year, settlement. 3 William c. 11, s. 6.

5. *Marriage.*—As a general rule, the wife follows the husband's settlement; but if the husband has no settlement, or it is not known at his death, her own settlement is restored. And if the husband deserts his wife, her settlement remains, except natives of Scotland, Ireland, the Isle of Man, Guernsey, or Jersey, who have no legal settlement, and may be sent home, on becoming chargeable, at the expense of the county.

6. *Estate.*—No person shall be removed from any estate while he remains on it. 9 George I. c. 7. But no person gains a settlement by an estate whose purchase was less than 30l. Ibid. Persons who have no settlement, as foreigners, or whose settlement cannot be known, as deserted infants, must be kept by the parish where they happen to be.

*Removals.*—So much of 13, 14 Charles II. c. 12, as enables justices to remove persons likely to become chargeable, is repealed; and no person can now be removed until actually chargeable. 35 George III. c. 101, s. 1. Justices may suspend removal of persons ill, either under a vagrant pass, or order of removal; expense attending the suspension to be paid by the parish officers of the place to which the pauper is to be removed; on refusal to pay within three days, to be recovered by distress and sale with costs not exceeding 40*s*. One justice. If out of the jurisdiction, warrant of distress to be backed by a justice having jurisdiction. Appeal to the sessions, if charges and costs exceed 20*l*. Ibid. s. 2. Every person convicted of larceny or felony, or deemed a rogue and vagabond, or disorderly person, or who shall appear to two justices, on oath of one witness, to be a person of evil fame or a reputed thief, and shall not give a satisfactory account of himself and way of living, and every unmarried woman with child, shall be deemed actually chargeable, and shall be removed as such. Ibid. s. 6. Persons refusing to go with an order of removal, or returning when removed, to be committed as a vagabond. One justice. 13, 14, Charles II. c. 12, s. 3. Parish officer refusing to receive a person so sent, to be bound to the assizes or sessions to answer the contempt. One justice. Ibid. If removed into another county or jurisdiction, and the parish officer refuse to receive, penalty 5*l*. Application to the parish of the place, from which the pauper is removed. Recovery by distress, and, in default, commitment for forty days. One justice of the jurisdiction to which removed. Two witnesses, 3 William, c. 11, s. 10. Appeal from orders of removal to the sessions of the county from which the pauper was removed. 8, 9 William, c. 30, s. 6. It must be to the sessions of the county, and not of any corporate town.

POOR'S *Rate*, an assessment raised through England and Wales, for the temporary relief, or permanent maintenance, of all such persons as from age, infirmity, or poverty, cannot themselves procure the means of subsistence. The total sum raised by the poor's rate and other parochial rates within the year, ending Easter 1822, was 7,695,534l. of which 6,358,702l. were expended in support of the poor, and 1,336,632l. for other purposes. The poor's rate has gone on at an alarming increase since the peace in 1815, in which year 5,418,845l. were expended in their support.

POPE, *Papa, Father*, the sovereign pontiff, or supreme head of the Romish church.

POPULATION *of the World*, agreeably to a general census framed in the year 1825, from which it would appear, that under the metaphysical titles following, the whole human race are said to stand thus:—

| | |
|---|---|
| Jews,........................... | 4,000,000 |
| Pagans,......................... | 456,000,000 |
| Mahomedans,..................... | 140,000,000 |
| Christians,..................... | 200,000,000 |
| Total,............ | 800,000,000 |

Deists and Atheists are comprehended, but not distinguished in either of these enumerations, as they do not avow themselves by any formation into bodies, but are anomalies in each class.—It is worthy of notice, that the most ancient congregation, *viz*. Pagans, still subsist throughout the globe, and comprise more than one-half of its general population; that the second in order of time, *viz*. Jews, have, since the destruction of their temple and city, in A. D. 70, fallen so near to decay, as to comprise only a 200th part of the whole; that the third denomination, *viz*. Christians, now include one-fourth part of the whole; and that the Mahomedans, who sprung up six centuries after the Christians, and threatened to annihilate them, occupy the space of one-sixth part of the whole. It is also observable, that when an estimate of this kind was made about fifty years since, it was supposed that Christians amounted to one-sixth part, and now they have increased to one-fourth. A step further in this inquiry disposes of the Christians thus, in their subdivisions:—

| | |
|---|---|
| The Greek and Eastern Churches,....... | 30,000,000 |
| Roman Catholics,.......................... | 100,000,000 |
| Protestants, including all sects,........... | 70,000,000 |
| Total,............. | 200,000,000 |

Those have all arisen since the promoting of the Universal Christian Church, 4,000 A. M. of which—

| | |
|---|---|
| The Western and Eastern Churches began and united in the | 6th Century. |
| Their separation, | 9th do. |
| Mahomed, | 7th do. |
| Christianity in Great Britain, | 7th do. |
| Darkness of Popery and Mahomedanism, | 6th to 16th do. |
| Waldenses, | 12th do. |
| Wickliffe, Huss, and Jerome, | 13th to 15th do. |
| Luther and Calvin, | 16th do. |
| Reformation, | 16th do. |
| Remonstrants, | 17th do. |
| Protestant sects, | 17th & 18th do. |

It is unnecessary to enlarge this scale; the object is thus answered by shewing the divisions of people, and their denominations and dates, by which any person, conversant in such researches, will find occupation enough for his reflection upon the probable state of mankind during the *ensuing half* century, under the advantages of an unexampled improvement in every country and condition, both in arts, navigation, and commerce, domestic and universal; an enriched acquisition of every embellishment of intellect, literature, and the fine arts; chemistry, and religious learning; an enlarged and liberal toleration in Church and State; a diffusion most unparalleled of the Holy Scriptures, of education, and a general intercourse among all nations.

In the lists of births and deaths in the kingdom of Bohemia, published for 1824, there is a considerable excess of births. In the capital, Prague, there were, out of 4436 deaths, 1633 of infants under a year old. The number of suicides was 105, or about one in forty. In London, in 1821, there were but 82 suicides out of 18,458 deaths, within the limits of the bills of mortality, or one in 225. In 1822 there were only 33 suicides in the bills of mortality. In Paris there were, in 1824, about 360 or 370, out of a population smaller than that of London: so false is the notion that we are, as compared with our neighbours, an eminently self-killing people. We are, in truth, not above a quarter part as suicidal as the people of Paris, and not much more than a sixth part so than the people of Prague.

**POPULUS** Alba. (*White Poplar.*) This is a very ornamental tree. The leaves on the under surface are of a fine white, and on the reverse of a very dark green; and when growing on large trees are truly beautiful, as every breath of air changes the colour as the leaves move. The wood of all the species of poplar is useful for boards, or any other purpose, if kept dry. It is much in demand for floor boards for rooms, it not readily taking fire; a red-hot poker falling on a board, would burn its way through it, without causing more combustion than the hole through which it passed.

Populus *Monilifera.* (*Canada Poplar.*) This is also known by the name of Black Italian Poplar, but from whence it had this name we do not know. This species, which is the finest of all the kinds, grows very commonly in woods and hedges in many parts of Worcestershire and Herefordshire, where it reaches to prodigious sizes. Perhaps no timber is more useful than this; it is very durable, and easy to be converted to all purposes in building. The floors of a great part of Downton Castle, the seat of R. Payne Knight, Esq. are laid with this wood, which have been used forty years, and are perfectly sound. Trees are now growing on his estate which are three and four feet in diameter.

Populus *Nigra.* (*The Black Poplar.*) *Its Buds.* The young buds or rudiments of the leaves, which appear in the beginning of spring, abound with a yellow, unctuous, odorous juice. They have hitherto been employed chiefly in an ointment, which received its name from them, though they are certainly capable of being applied to other purposes; a tincture of them, made in rectified spirit, yields upon being inspissated, a fragrant resin superior to many of those brought from abroad.

**PORCELAIN**, a fine sort of earthenware, chiefly manufactured in China, and thence called china-ware. The combination of silex and argil is the basis of porcelain; and, with the addition of various proportions of other earths, and even of some metallic oxides, forms the different varieties of pottery, from the finest porcelain to the coarsest earthenware.—Though silicious earth is the ingredient which is present in largest proportion in these compounds, yet it is the argillaceous which more particularly gives them their character, as it communicates ductility to the mixture when soft, and renders it capable of being turned into any shape on the lathe, and of being baked. The clays are native mixtures of these earths; but they are often rendered unfit for the manufacture of at least the finer kinds of porcelain, from other ingredients which they also contain. The perfection of porcelain will depend greatly on the purity of the earths of which it is composed; and hence the purest natural clays, or those consisting of silex and argil alone, are selected. Two substances have been transmitted to Europe as the materials from which the Chinese porcelain is formed, which have been named *Kaolin* and *Petunse.* It was found difficult to procure, in Europe, natural clays equally pure, and hence in part the difficulty of imitating the porcelain of the East. Such clays, however, have now been discovered in different countries; and hence the superiority to which the European porcelain has attained. The fine Dresden porcelain, that of Berlin, the French porcelain, and the finer kinds which are formed in this country, are manufactured of such clay, which from the use to which it is applied, has received the name of porcelain earth, and which appears, in general, to be derived from the decomposition of felspar of granite. It appears also that natural earths, containing magnesia, are used with advantage in the manufacture. The proportion of the earths to each other must likewise be of importance; and from differences in this respect arise, in part, the differences in the porcelain of different countries, as well as the necessity frequently of employing mixtures of natural clays. The argil communicates tenacity and ductility to the paste, so that it may be easily wrought; the silex gives hardness and infusibility; and on the proper proportion of these depends, in a great measure, the perfection of the compound. The proportion of silex in porcelain of a good quality, is at least two-thirds of the composition; and of argil, from a fifth to a third. Magnesia is of utility, by lessening the tendency which the composition of silex and argil alone has to contract in baking, which is inconvenient in the manufacture.

Porcelain *of Reaumur.*—Reaumur gave the quality of porcelain to glass; that is, he rendered glass of a milky colour semi-transparent, so hard as to strike fire with steel, infusible, and of a fibrous grain, by means of cementation. The process which he published, is not difficult. Common glass, such as that of which wine bottles are made, succeeds best. The glass vessel which is to be converted into porcelain is to be enclosed in a baked earthen case or seggar. The vessel and case are to be filled with a cement composed of equal parts of sand and powdered gypsum or plaster, and the whole is to be put into a potter's kiln, and to remain there during the baking of common earthenware; after which the vessel will be found transformed into such a matter as has been described.

**PORE**, in Anatomy, a little interstice or space between the parts of the skin serving for perspiration. Pores are small interstices between the particles of matter which compose bodies; and are either empty, or filled with some insensible medium. Condensation and rarefaction are only performed by closing and opening the pores.

**PORIME**, Porima, in Geometry, a sort of lemma or theorem, so obvious or self-evident as to differ but little from an axiom or self-evident proposition.

**PORISM**, Porisma, in Geometry, is a peculiar sort of proposition, which has been differently defined by different writers, some considering it as a general theorem or canon, deduced from a geometrical locus, and serving for the solution of other general and difficult problems; while others make it a lemma, or the same as porima. Dr. Simson defines it a proposition, either in the form of a problem or a theorem, in which it is proposed either to investigate or demonstrate. Euclid wrote three books of porisms, being a curious collection of various things relating to the analysis of the more difficult and general problems. Those books, however, are lost, and nothing remains in the works of the ancient geometricians, concerning this subject, besides what Pappus has preserved, in a very imperfect and obscure state, in his "Mathematical Collections," *viz* in the introduction to the seventh book.

**PORISTIC Method**, in Mathematics, is that which determines when, by what means, and how many different ways, a problem may be resolved.

**POROSITY**, an essential property of bodies, is best ascertained by the microscope, which shews us the passage of fluids through solid bodies; or we may discover this property in the transmission of light in all directions through the internal structure of hard and solid bodies. The porosity of wood is very remarkable. Air may be blown by the mouth, in a profuse stream, through a cylinder two feet long of dried oak, beech, elm, or birch; and if a piece of wood, or a piece of marble, be dipped in water, and submitted to experiment under the receiver of a pneumatic machine, the air issuing through the exterior cavities will appear in a torrent of bubbles on the external surface. In like manner mercury is forced through a piece of dry wood, and made to fall in the form of a fine divided shower. If a few ounces be tied in a bag of sheep skin, it may be squeezed through the leather by the pressure of the hand, in numerous minute streamlets. This experiment illustrates the porosity of the human cuticle. From microscopic observations, it has been computed that the skin is perforated by a thousand holes in the length of an inch. If we estimate the whole surface of the body of a middle-sized man to be sixteen square feet, it must contain no fewer than 2,304,000 pores. These pores are the mouths of so many excretory vessels, which perform that important function in the animal economy, *insensible perspiration*. The lungs discharge every minute six grains, and the surface of the skin from three to twenty grains, the average over the whole body being fifteen grains of lymph, consisting of water, with a very minute admixture of salt, acetic acid, and a trace of iron. If we suppose this perspirable matter to consist of globules only ten times smaller than the red particles of blood, or about the 5000th part of an inch in diameter, it would require a succession of 400 of them to issue from each orifice every second. The permeability of a solid body to any fluid, depends however on its peculiar structure and its relation to the fluid. A compact substance will sometimes oppose the entrance of thin fluid, while it gives free passage to a gross one. Thus, a cask, which holds water, will permit oil to ooze through it; and a fresh humid bladder, which is air-tight, will yet, when pressed under water, imbibe a notable portion of that liquid. If a cylindrical piece of oak, ash, elm, or other hard wood, cut in the direction of its fibres, be cemented to the end of a long glass tube, water will pass freely through it, in divided streamlets; but a soft cork inserted into a similar tube will effectually prevent all escape of the liquid. Mercury may be carried in a small cambric bag, which could not retain water for a moment. If a circular bottom of close-grained wood, divided by a fine slit from the 30th to the 100th part of an inch wide, be cemented to the end of a glass tube, it will support a column of mercury from one to three or more inches high, the elevation being always proportional to the narrowness of the slit. Hence a cistern of box-wood is frequently used for portable barometers, the fine joints admitting the access and pressure of the air, but preventing the escape of the mercury. Yet a sufficient force would overcome this obstruction; and, in the same manner, the air which is confined in the common bellows under a moderate pressure, might, by a more violent action, be made to transpire copiously through the boards and the leather. The transmission of a fluid through a solid substance shews the existence of pores; but the resistance, in ordinary cases, to such a passage, is insufficient, therefore, to prove the contrary. The permeability of translucent substances to the rays of light, in all directions, evinces the most extreme porosity. But this inference is not confined merely to the bodies usually termed diaphanous; for the gradation towards opacity advances by insensible shades. The thin air itself is not perfectly translucid, nor will the densest metal absolutely bar all passage of light. The whole mass of our atmosphere, equal to the weight of a column of thirty-four feet of water, transmits, according to its comparative clearness, only from four-fifths to three-fourths of the perpendicular light, and consequently retains or absorbs from a fifth to a fourth of the whole. But this absorption is greatly increased by the accumulation of the medium. When the sun has approached within a degree of the horizon, and his rays now traverse a tract of air equal in weight to a column of 905 feet of water, only the 212th part of them can reach the surface of the earth. By a peculiar application of my Photometer, I have found that half of the incident light, which might pass through a field of air of the ordinary density and 15½ miles extent, would penetrate only to the depth of fifteen feet in the clearest sea-water, which is therefore about 5400 times less diaphanous than the atmospheric medium. But water of shallow lakes, though not apparently turbid, betrays a greater opacity, insomuch, that the perpendicular light is diminished one-half, in descending only through the space of six, or even two feet. The same measure of absorption would take place in the passage of light through the thickness of two or three inches of the finest glass, which is consequently 500,000 times more opaque than an equal bulk of air, and even 300 times more opaque than a corresponding mass of that fluid. But even gold itself is diaphanous. If a leaf of that metal, either pure or with only an 80th part of alloy, and therefore of a fine yellow lustre, but scarcely exceeding the 300,000th part of an inch in thickness, and enclosed between two thin plates of mica, be held immediately before the eye, and opposite to a window, it will transmit a soft green light, like the colour of the water of the sea, or of a clear lake of moderate depth. This glaucous tint is easily distinguished from the mere white light which passes through any visible holes or torn parts of the leaf. It is indeed the very colour which gold itself assumes, when poured liquid from the melting pot. A leaf of pale gold, or gold alloyed with silver, transmits an azure colour; from which we may, with great probability, infer, that if silver could be reduced to a sufficient degree of thinness, it would discharge a purple light. These noble metals, therefore, act upon white light exactly as air and water, absorbing the red and orange rays, which enter into its composition, but allowing the conjoined green and blue rays to effect their passage. If the yellow leaf were estimated to transmit only the tenth part of the whole incident light, it would only follow, that pure gold is 250,000 times less diaphanous than pellucid glass. The inferior ductility of the other metals will not allow that fine lamination, which would be requisite for shewing, in ordinary cases, the transmission of light. But their diaphanous quality might be inferred from the tints with which they affect the transmitted rays, on being alloyed with gold. Other substances, though commonly reckoned opaque, yet admit in various degrees the passage of light. The window of a small apartment being closed by a deal board, if a person within shut his eyes a few minutes to render them more acute, he will, on opening them again, easily discern a faint glimmer issuing through the window. In proportion as the board is planed thinner, more light will be admitted, till the furniture of the room becomes visible. Writing paper transmits about a third part of the whole incident light, and when oiled it often supplies the place of glass in the common workshops. The addition of oil does not, however, materially augment the diaphanous quality of the paper, but renders its internal structure more regular, and more assimilated to that of a liquid. The rays of light travel, without much obstruction, across several folds of paper, and even escape copiously through pasteboard. Combining these various facts, it follows that all bodies are permeable, though in extremely different degrees, to the afflux of light. They must therefore be widely perforated, and in every possible direction. The porosity of bodies is consequently so diffuse, that the bulk of their internal kernel, or of the ultimate obstacles which they present, may bear no sensible proportion to the space which they occupy.

**PORPHYRY**, derives its name from the Greek word signifying red, as the porphyry used by the ancients was most frequently of that colour. The term porphyry is very vague, being applied to all rocks that have a compact base or ground in which crystals of any kind are imbedded and distinctly visible. Thus, according to the kind of stone in which the crystals occur, the porphyry takes its more appropriate name, as horn stone porphyry, clay-stone porphyry, pitch-stone, and obsidian porphyry, &c. The base of porphyry is generally allied to trap, and is fusible. The crystals are either quartz or felspar, but more commonly the latter, forming four-sided or six-sided prisms, whose length is greater than the breadth.

**PORT**, a harbour or haven on the sea-coast. *Bar Port*, is such as can only be entered with the tide. *Close Port*, is one within the body of a city, as the ports of Rhodes, of Venice, Amsterdam, Rochelle, Bayonne, and St. Jean de Luz. *Free Port*, is one open and free for merchants of all nations to load and unload their vessels in, without paying any duty or customs; such are the ports of Genoa and Leghorn. *Free Port*, is also used for a total exemption and franchise which any set of merchants enjoy, for goods imported into a state, or those of the growth of the country exported. Such was the privilege the English enjoyed for several years after their discovery of the port of Archangel, and which was taken from them on account of the regicide in 1648.

**Port**, is also a name given, on some occasions, to the larboard or left side of the ship, as in the following instances:—*The Ship Heels to Port*, *i. e.* stoops or inclines to the larboard side. *Top the Main yard to Port*, the order to sway the larboard extremity of that yard higher than the other.

**Port**, is also used for the burden of a ship.

**Port** *the Helm*, the order to put the helm over to the larboard side of the vessel, when going large. In all these cases, this word appears intended to prevent any mistakes happening from the similarity of sounds in the words starboard and larboard, particularly when they relate to the helm, where a misapprehension might be attended with very dangerous consequences: accordingly the word larboard is never used in conning.

*Half* **Port**, a kind of shutter, with a circular hole in the centre, large enough to go over the muzzle of the gun, and furnished with a piece of canvas, nailed round its edge, to tie upon the gun, whereby the water is prevented entering at the port, although the gun remains run out. They are principally used upon the main-deck, and particularly in ships carrying one tier of cannon.

**Port** *Bars*, strong pieces of oak, furnished with two lanyards or ropes, by which the ports are secured from flying open in a gale of wind, the bar resting against the inside of the ship, and the port being firmly lashed to it by its two ringbolts.

**Port**-*Last*, or *Portoise*, is synonymous with Gunwale; as, *Lower the Yards a Port last*, that is, down to the gunwale. *To Ride a Portoise*, is to have the lower-yards and top-mast struck, or lowered down, when at anchor in a gale of wind.

**Port** *Lids*, a sort of hanging doors, to shut in the ports at sea; they are fastened by hinges to the upper edges, so as to let down when the cannon are drawn into the ship, whereby the water is prevented entering the lower decks. They are more generally termed Ports.

**Port** *Ropes*, ropes made fast to the outside of the portlids, and communicating with a tackle within, by which the portlids are occasionally drawn up.

**Port** *Tackles*, are those mentioned in the preceding article, as serving to haul up or open the ports.

**Port** *Holes*, in a ship, are the holes in the side of the vessel through which are put the muzzle of the great guns. These are shut up in storms, to prevent the water from driving through them.

**PORTA**, John Baptista, a Neapolitan, eminent for his learning. As he admitted a society of learned friends into his house, he was accused of magical incantations, and exposed to the censures of Rome. He died 1515, aged 70. He invented the camera obscura, improved afterwards by Gravesande, and formed the plan of an encyclopedia. He wrote a Latin treatise on natural magic, 8vo.; another on physiognomy, mixed with astrology, &c.

**PORTCULLIS**, in Fortification, is an assemblage of several large pieces of wood, joined across one another like a harrow, and each pointed with iron at the bottom. They are sometimes hung over the gateway of old fortified towns, ready to let down in case of surprise, when the gates cannot be shut.

**PORTER**, a kind of malt liquor which differs from ale and pale beer in being made of high-dried malt.

**PORTGREVE**, or Portgrave, anciently called the principal magistrate in ports and other maritime towns. The word is formed from the Saxon "port," and "geref" a governor. It is sometimes also written "portreve." It is said by Camden, that the chief magistrate of London was anciently called portgreve, which was exchanged by Richard I. for two baliffs; and these again gave place, in the reign of King John, to a mayor, who was an annually elected magistrate.

**PORTLAND** Stone, is a dull whitish species much used in buildings about London. It is composed of a coarse grit cemented together by an earthy spar.

**PORTRAIT**. *See* Painting.

**PORTS**, the embrasures or openings in the side of a ship of war, wherein the artillery is ranged in battery upon the decks, above and below. *Gun-room Ports*, are situated in the ship's counter, and are used for stern-chases, and also for passing a small cable or a hawser out, either to moor, head and stern, or to spring upon the cable, &c. *Lower-deck Ports*, are those on the lowest gun-deck. *Middle deck Ports*, are those on the second or middle gun-deck of three-deckers.

**POSITION**, or *the Rule of False Position*, otherwise called the Rule of Falsehood, in Arithmetic, is a rule so called because in calculating on several false numbers taken at random, as if they were the true ones, and from the differences found therein, the number sought is determined. The rule is either single or double.—Single Position, is when there happens in the propositions some partition of numbers into parts proportional, in which case the question may be resolved at one operation, by this rule: Imagine a number at pleasure, and work therewith according to the tenor of the question, as if they were the true number; and what proportion there is between the false conclusion and the false proportion, such proportion the given number has to the number sought Therefore the number found by augmentation, shall be the first term of the rule of three; the second number supposed, the second term; and the given number, the third. Or the result is to be regulated by this proportion, *viz.* As the total arising from the error, to the true total, so is the supposed part to the true one. Example: A, B, and C, designing to buy a quantity of lead to the value of 140*l.* agree that B shall pay as much again as A; and C as much again as B; what must each pay. Now suppose A to pay 10*l.* then B must pay 20*l.* and C 40*l.* the total of which is 70*l.* but it should be 140*l.* Therefore, if 70*l.* should be 140*l.* what should 10*l.* be? Answer, 20*l.* for A's share, which doubled makes 40*l.* for B's share, and that again doubled, gives 80*l.* for C's share, the total of which is 140*l.*—Double Position, is when there can be no partition in the numbers to make a proportion. In this case, therefore, you must make a supposition twice, proceeding therein according to the tenor of the question. If neither of the supposed numbers solve the proportion, observe the errors, and whether they are greater or less than the supposition requires, mark the errors accordingly with the sign $+$ or $-$. Then multiply contrariwise the one position by the other error; and if the errors are both too great or both too little, subtract the one product from the other, and divide the difference of the products by the difference of the errors. If the errors are unlike as the one $+$ and the other $-$, add the products, and divide the sum thereof by the sum of the errors added together, for the proportion of the excesses or defects of the numbers supposed to be the number sought; or the suppositions and their errors being placed as before, work by this proportion as a general rule, *viz.* as the difference of the errors if alike, or their sum if alike, to the difference of the suppositions, so either error, to a fourth number; which accordingly added to or subtracted from the supposition against it, will answer the question.—Such are the instructions commonly given in books of arithmetic on this subject; but it were certainly better to abandon all these rules, and solve questions of this stamp by means of equations and algebraic analysis. Thus, let us take the example before us, in single position, as it is called; and

Let $x =$ A's share; $2x =$ B's share; $4x =$ C's share; then, by the question $x + 2x + 4x = 140$, or $7x = 140$

$\therefore x = \frac{140}{7} =$ £20 for A's share, which doubled makes £40

for B's share; and this last doubled gives £80 for C's share. Any person capable of handling an equation, may thus work out questions in position, without staring at the supposed wisdom and ability of a poor pedagogue bringing out the answer by *trials*

*Example.* What number is that which, being multiplied by 6, the product increased by 18, and the sum divided by 9, the quotient shall be 20.

Let the two supposed numbers be 18 and 30.

$$\begin{array}{rr}
\text{Then } 18 & 30 \\
6 & 6 \\
\hline
108 & 180 \\
18 & 18 \\
\hline
9\,)\,126 & 9\,)\,198 \\
\hline
14 \text{ the 1st result.} & 22 \text{ the 2d result.}
\end{array}$$

Then $22 - 14 : 30 - 18 :: 20 - 14$

Or, $8 : 12 :: 6 : 9$, the correction to 1st supposition; therefore $9 + 18 = 27$, the number sought. By Algebra,

Let $x =$ the number sought; then $\frac{x \times 6 + 18}{9} = 20$ by the question; *i.e.* $x \times 6 + 18 = 180$, or $6x + 18 = 180$. By transposition, $6x = 180 - 18 = 162$, or $6x = 162$, therefore $x = \frac{162}{6} = 27$.

**POSITION**, in Astronomy, relates to the sphere. The position of the sphere is either right, parallel, or oblique; whence arise the inequality of days, the difference of seasons, &c.

*Circles* of Position, are circles passing through the common intersections of the horizon and meridian, and through any degree of the ecliptic, or the centre of any star, or other point in the heavens, used for finding out the position or situation of any star. These are usually counted six in number, cutting the equator into twelve equal parts, which the astrologers call the celestial houses.

*Centre* of Position. *See* Centre.

*Given* in Position, in Geometry, is an expression made use of to denote that the position or direction of a line is given or known.

*Geometry* of Position, is a species of geometry first treated of by Carnot, the object of which is to investigate and determine the relation that has place between the position of the different parts of a geometrical figure with regard to each other, or with regard to some determinate line or figure first fixed upon as a term of comparison, and which is called the primitive system, while that compared with it is denominated the transformed system; and as long as the different parts of the transformed system have the same directions or positions with regard to each other, their relation is said to be *direct*, but when they are different, *inverse*.

**POSITIVE** Electricity. In the Franklinian system, all bodies supposed to contain more than their natural quantity of electric matter, are said to be positively electrified; and those from whom some part of their electricity is supposed to be taken away, are said to be electrified negatively These two electricities being first produced, one from glass, the other from amber or rosin, the former was called vitreous, the other resinous, electricity.

Positive *Quantities*, in Algebra, are those which are affected with the sign + being affirmative or addative, in contradistinction to negative quantities, which are to be subtracted.

**POSSESSION**, is two-fold; actual, and in law. Actual possession, is when a man actually enters into lands and tenements to him descended. Possession in law, is when the lands and tenements are descended to a man, and he has not as yet actually entered into them. Staundf. 198.

**POST**, a military station. Thus the detachments established in front of the army are termed out-posts; the stations on the wings of the army are said to be posts of honour, as being the most conspicuous and most exposed. But in the operations of a campaign, a post properly signifies any spot of ground capable of lodging soldiers, or any situation, whether fortified or not, where a body of men may make a stand, and engage the enemy to advantage. The great advantages of good posts, in war, as well as the mode of securing them, are only learned by experience. Barbarous nations disdain the choice of posts, or at least are contented with such as immediately fall in their way, they trust solely or chiefly to strength and courage; and hence the fate of a kingdom may be decided by the event of a battle. But enlightened and experienced officers make the choice of posts a principal object of attention. The use of them is chiefly felt in a defensive war against an invading enemy; as by carrying on a war of posts in a country where this can be done to advantage, the most formidable army may be so harassed and reduced, that all its enterprises may be rendered abortive. In the choice of a post, the general rules to be attended to are, that it should be convenient for sending out parties to reconnoitre, surprise, or intercept the enemy; that if possible it may have some natural defence, as a wood, a river, or a morass, in front or flank, or at least that it be difficult of access, and susceptible of speedy fortification; that it shall be so situated as to preserve a communication with the main army, and have covered places in the rear to favour a retreat; that it may command a view of all the approaches to it, so that the enemy cannot advance unperceived and rest concealed, while the detachment stationed in the post are forced to remain under arms; that it is not commanded by any neighbouring heights; and is proportioned in extent to the number of men who are to occupy and defend it. It is not to be expected that all these advantages will often be found united; but those posts ought to be selected which offers the greatest number of them.

Post, a conveyance for letters or despatches. The present establishment of the general post-office of Great Britain consists of a postmaster-general, to the duties of which station there have, for many years past, been two persons appointed, under the title of joint postmasters-general; a secretary; upwards of 150 assistants and clerks for the head letter-office in London, under the direction of a superintending president of the inland-letter department; and a comptroller of the foreign-letter office. Near 600 deputy postmasters throughout the kingdom, act under one principal, and nine riding surveyors. There are also distinct offices and clerks, acting under an accountant-general and a receiver-general; as well as a separate establishment for the two-penny, formerly the penny post, which, since the abolition of Mr. Palmer's appointment of surveyor and comptroller-general, has been new-modelled and greatly improved in all its branches. There is likewise a post-master-general of Scotland, with a secretary, comptroller, surveyor, and a separate establishment of all the requisite officers and clerks at Edinburgh, acting under the orders of the joint postmasters-general in London. The annual expense of management is about 350,000*l.* and the gross produce exceeds 1,300,000*l.* a year.

Post, *Two Penny*, a post established for the benefit of London and other parts adjacent, whereby any letter or small parcel is speedily and safely conveyed to and from all places within the bills of mortality, or within ten miles of the city. It is now managed by the general post-office, and receiving houses are established in most of the principal streets, for the more convenient transmission of letters.

Post, a particular mode of travelling. A person is said to travel post, in contradistinction to common journey travelling, when, in place of going on during his whole journey in the same vehicle, and with the same horses, he stops at different stages, to provide fresh horses or carriages, for the sake of greater convenience and expedition. As he thus uses the same mode of travelling that is employed for the common post, he is said to travel post, or in post, *i. e.* in the manner of a post.

Post *Disseisin*, a writ for him that, having recovered land or tenements by præcipe quod reddat, upon default of reddition, is again disseised by the former disseisor.

**POSTEA**, is the return of the proceedings by nisi prius into the court of Common Pleas after a verdict, and there afterwards recorded. Plowd. 211.

**POSTERN**, in Fortification, is a small gate generally made in the angle of the flank of a bastion, or in that of the curtin, or near the orillon, descending into the ditch; by which the garrison may march in and out unperceived by the enemy, either to relieve the works or to make private sallies, &c.

**POSTULATE**, in Geometry, a demand or petition, or a supposition so easy and self-evidently true, as needs no explanation or illustration; differing from an axiom only in the manner in which it is put, *viz.* as a request, instead of an assertion.

**POTASS.** This alkali is commonly called the vegetable alkali, because it is obtained from the ashes of vegetables. It has been discovered by Sir H. Davy to consist of a metal which he calls potassium, and two portions of oxygen and water. In the fashionable nomenclature of the day, it is called the hydrated deutoxide of potassium. In the arts of life, and indeed even in scientific investigations, we are not so much concerned with potassium, as with this very common and useful alkali in the state in which we find it.

Table of the saline product of one thousand lbs. of potass of the following vegetables:—*Saline Products.*—Stalks of Turkey wheat or maise, 198 lbs.; stalks of sunflower, 349 lbs.; vine branches, 162·6 lbs.; elm, 166 lbs.; box, 78 lbs.; sallow, 102 lbs.; oak, 111 lbs.; aspen, 61 lbs.; beech, 219 lbs.; fir, 132 lbs.; fern cut in August, 116 lbs.; or 125, according to Wildenheim; wormwood, 748 lbs.; fumitory, 360 lbs.; heath, 115 lbs. Wildenheim. In both cases a high-coloured liquor is separated, which is to be poured off; and the potash must be kept carefully secluded from air. A perfectly pure solution of potash will remain transparent on the addition of lime-water, shew no effervescence with diluted sulphuric acid, and not give any precipitate on blowing air from the lungs through it by means of a tube. About 100 parts of pure potass are equivalent to 70 of concentrated sulphuric acid; therefore a good alkalimeter may be made by having a graduated tube, which divided into 100 equal parts, let 70 be filled with acid and the rest with pure water. If the alkali be quite pure, it will require the whole liquid in the tube to saturate 100 of the alkali; but if less will be sufficient, such as 75 parts, then we know that there are only 75 per cent. pure alkali; and so on for any other proportion.

**POTASSIUM** is the metallic basis of potass, and may be obtained by placing hydrate of potass between two discs of platinum connected with the extremities of a powerful voltaic apparatus, when it will undergo fusion, and the oxygen will be separated, and the metallic globules will appear at the negative surface. When newly cut, it is splendent like silver, but soon tarnishes in the air, on which account it must be kept in a phial in pure naphtha. When thrown into the water, it swims on the surface, burning with a beautiful red mixed with violet. It combines with oxygen in different proportions.

**POTATOES.** The potatoe is the bulb that contains the largest quantity of soluble matter in its cells and vessels; and it is of most importance in its application as food. Potatoes in general afford from one-fifth to one-seventh their weight of dry starch. (Solanum Tuberosum, *Linn.*)

*Saintmarc's mode of Distilling from Potatoes.*—The intention of Saintmarc is to distil alcohol from potatoes, and the subject of his improvement is described under two heads; *viz.* the mode of preparing the potatoes, ready to be converted into wash, and the general arrangement of the apparatus for conducting the fermentation and distillation, so as to retain the natural flavour of the spirit, and at the same time economize the use of fuel. It is first proposed to wash the potatoes free from the earth which adheres to their skins, by placing them in a rotatory drum, formed by open rails or staves, which drum is immersed in a trough or other vessel filled with water. When thus cleansed, the potatoes are to be introduced into a mill, for the purpose of being ground to a pulp. The construction of the mill to be employed is rather peculiar; it consists of a box, as usual, containing a cylinder having ribs of iron set into the periphery of the cylinder, which ribs are to be notched, or formed on the outside into teeth like fine saws. Two pieces of wood at right angles, the one standing in a perpendicular, the other in a horizontal direction, are to be brought up against the cylinder on one side, and the potatoes, introduced from a hopper above, are let fall between the cylinder and the wood, when, by the rotation of the cylinder, at the rate of about four hundred revolutions per minute, the potatoes become ground to a pulp, which descends into a receptacle below, there being a wooden scraper behind the cylinder, in order to prevent the pulp from adhering. The perpendicular piece of wood is made to give way by means of a spring behind it, for the purpose of allowing the larger potatoes to come in contact with the cutting cylinder, and the horizontal piece of wood is adapted with screws, in order to keep it up constantly against the cylinder which wears away the wood as it revolves.

The pulp of the potatoes thus produced in the mill, is now to be mixed with a considerable quantity of water, sufficient to bring it into a liquid state; it is then strained through a sieve, and such portions of the potatoe as will not pass through the sieve are rejected as useless, and set apart for feeding animals. The liquor thus strained, is then to be poured into a sort of cullender, or vessel having many holes, which vessel is lined with a cloth; and here the pulp is allowed to settle, and the water to drain away, leaving the substance of the potatoe in a cake at bottom. This cake is then laid out upon a plaster floor, that its moisture may be drawn out by absorption, and afterwards it is dried in a kiln, where it may be kept perfectly good for a very great length of time.

In commencing the process of distillation from the prepared potatoes, the cake must be first broken and dissolved, by mixing with hot water till it has assumed the consistency of cream. A quantity of this liquor is then placed in a vat, which may be supposed to be situated as shewn at *a*, fig. 1. This figure shews the whole range of apparatus in action, from the vat *a*, in which the pulp is first introduced previous to femrentation, down to the worm where the distilled spirit is ultimately condensed.

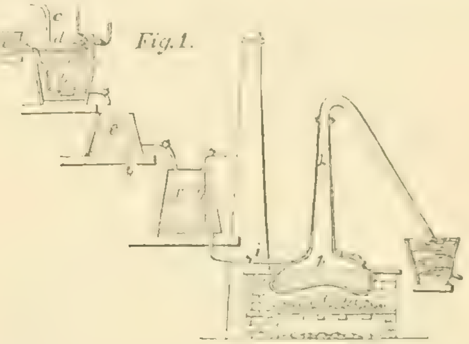


*Fig. 1.*

Let the quantity of potatoe pulp introduced into the vat *a*, be equal to about three hundred weight when in a dry state, but mixed in the vat with hot water, to about the consistency of cream, as before mentioned; let there be water poured into the vessel *b*, until it rises above six inches from the bottom, and into this water introduce twenty pounds of sulphuric acid, observing that the vessel, *b*, should have a lining of lead, to prevent the action of the acid upon the wood. The cock of the vat *a* is now to be opened, and the liquor contained therein allowed to flow into the vat, *b*, which is called the decomposing vessel. Another portion of the potatoe pulp may then be mixed in the vat, *a*, and let off into the vat, *b*, as before; and so on until the vat, *b*, is sufficiently full. The proportion of acid to the pulp, necessary for decomposing it, should be from two to three pounds of the former, to every hundred weight of the latter.

Steam is now to be sent into the vat *b*, through the pipe *c*, from a boiler, and by means of this steam the liquor in *b*, is made to boil, and is to be kept boiling for four or five hours. The steam which evaporates from the vat, *b*, is allowed to pass up a worm pipe in the tub, *d*, which by that means heats the water in the tub, so that none of the heat is lost, and hot water may then be drawn from the tub, through a pipe, to supply the vat *a*.

After the boiling in the decomposing vessel is complete, the liquor is let off into a third vat, *e*, which is called the saturating vessel. During the time that the liquor is flowing into this vessel, a quantity of lime and water, or chalk and water, is introduced, in order to neutralize the sulphuric acid; two or three pounds of chalk is generally sufficient for one of acid, but the introduction of the chalk or lime must be continued as long as any effervescence arises from the liquor.

When the liquor has subsided in the saturating vessel, it is to be drawn off into the fermenting vat, *f*, where a quantity of yeast is added, to promote the fermentation. The temperature of this vessel is to be kept up to about ninety or one hundred degrees of Fahrenheit's thermometer, and the room in which the operation is going on, to eighty or eighty-five degrees, during the whole time of its fermenting, which usually takes fifteen or twenty days. To facilitate the fermentation, hydrogen gas is proposed to be injected into the liquor, by means of a force pump through the pipe *g*, which has a number of small holes in the lower part of the pipe, branches from which are coiled about the bottom; but this injection need not be made when the carbonic acid gas, which escapes, contains an excess of hydrogen. This mode of introducing hydrogen into the wash, may be advantageously employed to facilitate fermentation, whenever liquor is intended for distillation. The sediment of the vat, *e*, should be stirred up, to prevent the loss of any saccharine matter, and allowed to run into the fermenting vat.

When the process of fermentation is complete, the liquor is to be run from the vat *f*, into the still, *h*, through the pipe, *i*, and is then to be operated upon in the usual way. The form of this still is, however, something different from those stills commonly used; it is without the usual hand, and it is here intended that the evaporation shall pass up the long tube, *k*, in doing which, it will become partially condensed, and run down again into the still; but the more volatile or spirituous part will pass over the neck at top, and proceed down the pipe to the worm *l*, immersed in cold water, where it will become condensed, and discharge itself at the extremity of the pipe into any vessel placed under it.

The produce of this first distillation is called low wine; it is therefore necessary to pass the liquor again through the still before it becomes a highly concentrated spirit. For this purpose it is to be carried to another still shewn at *a*, fig. 2. Here the operation of distilling is conducted in the ordinary way, and the spirituous vapour passing up the pipe, *b*, descends into the closed vessel *c*, which is cooled by a reservoir of cold water, in a trough, *d*, at top. Here the spirit boils, and as it rises passes up the pipe, *e*, and descends into a long cylindrical vessel, *f*. This vessel is immersed in a trough of cold water, and is divided by partitions into six compartments, having small bent pipes leading from one to the other. The heaviest portion of the spirit condenses in the first compartment, and the volatile part proceeds through the pipe to the next, where the second heaviest becomes condensed, and the lightest passes through all the compartments, and proceeds through the pipe, *g*, to the worm immersed in the tub, *h*, from whence it discharges itself into a suitable receiver.

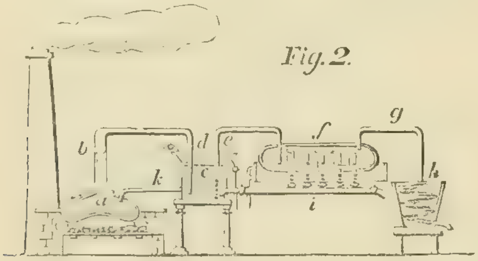


*Fig. 2.*

The spirit condensed in the cylindrical vessel, *f*, may be passed through the small pipes at the bottom of each compartment into the long pipe, *i*, and from thence drawn off for rectification, or it may be passed from the long pipe into the closed vessel, *c*, and from thence through the pipe *k* to the still for further distillation.

The specification concludes by stating, that the invention consists, first, in the process by which a spirituous liquor is obtained or extracted from potatoe; and, secondly, in the improved arrangement and construction of apparatus for effecting the processes of fermentation and distillation. [Inrolled Sept. 1824.]

*Another Method of obtaining Brandy from Potatoes is this.*—The potatoes are put into a close wooden vessel, and there boiled by steam, which is communicated to them at a degree little above that of boiling water; after they are boiled or steamed, they are reduced to a paste with extraordinary facility, (which is done by machinery in the interior of the wooden vessel;) they then add boiling water to the paste, and a little potash rendered caustic by quicklime; the addition of the alkali is to dissolve the vegetable albumen, which prevents the complete conversion of the potatoes into starch. The starch liquor, after being filtered and evaporated, gives a residue very pure, and susceptible of being treated chemically: we are then directed to draw off the brandy from the potatoes, which has the proper herbaceous taste: it is then mixed with chlorate of lime, by which process the brandy is rendered equal to that distilled from wine. It will be observed that there is some difference between this process of obtaining spirits from potatoes, and that described in the immediately preceding article.

**POTENTILLA** ANSERINA. (*Silverweed.*)—The sensible qualities of Anserina leaves promise no great virtue of any kind; for to the taste they discover only a slight roughness, from whence they were thought to be entitled to a place among the milder corroborants. As the astringency of tormentil is confined chiefly to its root, it might be thought that the same circumstance would take place in this plant; but the root is found to have no other than a pleasant sweetish taste, like that of parsnip, but not so strong.

POTENTILLA *Reptans.* (*Cinquefoil*, or *Five Leaved Grass.*)—The root is moderately astringent; and, as such, is sometimes given internally against diarrhœas and other fluxes; and it is employed in gargarisms for strengthening the gums, &c. The cortical part of the root may be taken, in substance, to the quantity of a dram; the internal part is considerably weaker, and requires to be given in double the dose, to produce the same effect. It is scarcely otherwise made use of than as an ingredient in Venice treacle.

**POTERIUM** *Sanguisorba.* (BURNET.)—This plant grows in calcareous soils, and is in some places much esteemed. On the thin chalky soils near Alresford in Hampshire, I have observed it to thrive better than almost any other plant that is cultivated. Sheep are particularly fond of it, and I have heard it said that the flavour of the celebrated Lansdown mutton arises from the quantity of burnet growing there. It is also the favourite food of deer. This will grow well in a calcareous soil, and there are few pastures but would be benefited by its introduction. Twenty-five pounds per acre are sown alone; eight pounds, mixed with other seeds, would be sufficient to give a good plant on the ground.

**POTTERY**, the art of making vessels from earth, is of the remotest antiquity. In the earlier ages of the world, almost all domestic utensils were of pottery, which may hence be fairly supposed the oldest of mechanical inventions. The Scriptures first mention the practice of this art. The numerous remains of Greek and Etruscan vases, prove that these nations were celebrated for their skill in pottery. The Greek vases in Sir William Hamilton's collection, deposited in the British Museum, are ornamented with truly elegant paintings, and their forms are equally simple and beautiful. Porcelain, (from the Portuguese word, *porcelena*, a cup,) the most perfect species of earthenware, is distinguished from the inferior kinds of pottery, which are opaque and of various colours, by its being white and semi-transparent. Europe has now excelled the Oriental nations in the art of making porcelain. Besides the manufactory of Saxony, which has been long established, porcelain is made at Vienna, at Frankendal, and lately in the neighbourhood of Berlin. In France, the Serres porcelain holds the most distinguished rank. Italy also has its porcelains, the best of which are those of Naples and Florence. The potteries of England have made rapid advances towards perfection. The chief establishments are in Staffordshire, at Derby, Worcester, Coalport, and Liverpool. The Staffordshire potteries have long been celebrated for their earthenwares, and some of the principal proprietors have directed their attention to the manufacture of porcelain, which has attained a high degree of excellence. The earthenwares formerly manufactured here were coarse; the finest sort was an imperfectly white ware, very slightly ornamented with blue, and glazed by throwing into the oven, while the ware was firing, a quantity of common salt; the salt was converted into vapours, and, applied to the surface of the vessels, formed the glazing. The colour of the body of this kind of ware is said to have received considerable improvement from the following incident; Mr. Astbury, a Staffordshire potter, travelling to London, perceiving something amiss with one of his horses' eyes, a hostler at Dunstable offered to cure the animal, and for that purpose put a common black flint stone into the fire. When taken out, it was observed to be of a fine white: the potter immediately conceived the idea of improving his ware, by adding this material to the whitest clay he could obtain. He sent home a quantity of the flint stones, and, by mixing them with tobacco-pipe clay, produced a white stone ware superior to any that had been made before. The other potters followed his example.—In 1763, Wedgwood invented a species of earthenware new in its appearance, and covered with a rich and brilliant glaze, called queen's ware. Hence may be dated a new æra in this interesting and important manufacture. Wedgwood's ware evinces considerable taste in the elegance of his antique models, and in the excellence of their execution. Spode's ware, or blue and white, in imitation of the Oriental china, or porcelain, has been introduced with great success in various manufactories. The potteries in Staffordshire are not less than one hundred in number; employing more than ten thousand persons; and the annual value of goods manufactured there, may be estimated, in the most flourishing times, at eight hundred thousand pounds sterling. A canal furnishes the manufacturers with the means of water-carriage to every principal sea-port in the kingdom; greatly facilitating the exportation of the manufactured articles, and the importation of the raw material. The number of persons employed in Spode's establishment amounts to more than seven hundred, and the latest discoveries in machinery are applied to the advancement of the art.

We now proceed to describe the general processes pursued at Spode's manufactory, and which may be classed thus:—Preparations of the raw material—moulding and turning—firing—printing—glazing—and painting.

In the preparation of the raw material, a powerful steam-engine performs many of the processes formerly carried on by manual labour. The bodies of earthenware are composed of Kent flint and West of England clay. The flint is first calcined in kilns, similar to those in which lime is burnt; it is then broken by revolving hammers, put in motion by the steam-engine, and afterwards conveyed into the pans, paved with stone, to be ground with water. In the centre of the pans there is an upright shaft, from which several transverse arms branch out, having very heavy stones placed between them; these stones, moved horizontally by the steam-engine, grind the flints, until they form a cream-like liquid, which is let off into the wash-tub, where the coarser particles are separated from the fine; the latter runs off into reservoirs, and the former is carried back to the grinding pan. When the ground flint is wanted for use, it is conveyed from the reservoir by a pump worked also by the steam-engine.

The process of preparing the clay, and mixing it with the flint, is this:—The clay is drawn up into the upper chamber of the slip-house, and there thrown into an iron box, in which moves a shaft, with knives fixed in it, to cut the lumps into small pieces. The clay is now laid in a cistern with a proper quantity of water, where it softens, and is then put into the plunging-tub; in this tub the water and clay are stirred until they become thoroughly mixed. The liquid is now drawn off into another cistern, from which it passes through a silk sieve into a third cistern, then into a fourth, through silk sieves still finer, the ground flint and other ingredients are now brought and mixed together; and the whole passes through sieves of a greater degree of fineness, into a fifth cistern: in this is a pump that throws it into a trough for conveying it to the drying kiln. All these various operations are worked by the steam-engine, and there are fourteen sieves in motion at one time. After the clay has been dried, it is taken from the kiln and laid together in large heaps, and before it is worked into the vessels for which it is destined, the air-bubbles are disengaged from it. This is done by a machine turned by the steam-engine; the machine is an iron box shaped like an inverted cone, with an upright shaft in its centre, to which are affixed knives to cut the clay which is put into the box, by their rotatory motion; and, at the same time, so arranged, as to force it downwards to a square aperture at the bottom, it escapes through this in a sufficiently compressed state for the workmen, and is then cut into square pieces of a convenient size to be distributed in the manufactory. Near the steam-engine are work-shops for those branches of the trade which require the aid of machinery; and in this building there are eight throwing wheels, and twenty-five turning lathes. Underneath these shops are drying-houses, heated by steam, in which the ware is dried, previously to its going to the oven to be fired; above the work-shops is a single room capable of holding two hundred workmen.

*Moulding and Turning.*—Tea-cups, saucers, basons, jugs, and such like vessels, receive their first shape from the hands of the thrower, who sits on a stool with a flat circular wooden wheel before him, moving horizontally on a pivot. This wheel is set in motion by the steam-engine, and the workman can increase or diminish its velocity as there is occasion. Upon the centre of the wheel the operator throws a lump of clay, of the required size, and forms it into almost any shape with the utmost facility: it is then cut from the wheel by a wire, and taken to be dried, that it may acquire sufficient hardness to fit it for the next operation. By turning, the superfluous parts of the clay are taken off, so as to render the article perfectly smooth, and to give it the exact shape. The lathes on which the vessels are turned, are also put in motion by the steam-engine, and regulated as to speed by the turner himself. The principle of turning earthenware is very similar to that employed in wood-turning.—The vessels requiring handles and spouts, are taken to the handling room, and those which do not want this appendage, after having attained the requisite hardness, are sent to the oven to be baked. The handles, made on a mould of plaster of Paris, are fixed to the vessel with a liquid mixture of the same material as the vessel itself.

For the formation of various articles manufactured in all potteries, moulds made of plaster of Paris are necessary. The modeller forms the shape of the intended vessel out of a solid lump of clay, which after receiving his finishing touches, is handed to the person who makes the plaster mould from it. Plates and dishes are made from moulds of this kind, upon which the operator lays a piece of clay of the length, breadth, and thickness required; the mould and clay are then placed upon a wheel turning horizontally on a pivot, and the operator keeps peeling round with the left hand, and presses the clay to the shape of the mould with the other. The mould and dish together are then carried into a stove moderately heated, where it remains until sufficiently dried to separate. The plate or dish is then cut even at the edges, and in other respects finished: before they are baked, the dishes are laid flat upon plaster or stone flags that are quite level, in order that they may remain straight until they go to the oven to be fired. Tureens, vegetable dishes, and such articles, are also made in moulds, but require more time and care, being less simple in their form. Figures, flowers, and foliage in bas-relief, are also formed separately in moulds, and afterwards affixed to the vessel with diluted clay.

*Firing.*—When the ware is ready for firing, it is placed in clay cases called saggars, which vary in size and shape according to the articles placed in them. The saggars are put into an oven, shaped like a bee-hive, with an opening at the top; there is also an opening at the side to admit the saggars, but this is closed before the fire is applied. Each saggar is luted to the other by a roll of soft fire-clay. This secures the vessels contained in them from dust, the fumes of the fires, and from the effects of the air when the oven is cooling. The fires which heat the oven are placed round it in proper receptacles, which communicate with the interior of the oven by flues, heating every part equally. This first firing gives a higher degree of heat, and is continued much longer than any successive firing; when once fired, the article is called biscuit-ware. The cream-coloured, or queen's-ware, is now carried to the dipping-house to receive its glazing; that which is to be printed blue is taken to the printing-house.

*Printing.*—The design is previously engraven on a copper-plate, and laid on a stone to warm. The colour (which has oxide of cobalt for its basis) is mixed with a preparation of oils, to fetch out the impression. This mixture is smeared over the surface of the plate, and again cleaned off, leaving the liquid in the engraving only. The paper used to take off the impression is made expressly for this purpose; it is damped, laid on the copper-plate, and passed between two iron-rollers, as in ordinary copper-plate printing. The design being transferred to the paper, is laid immediately upon the ware, being rubbed on with a flannel. After remaining a short time, the ware is put into a tub of water, and the paper is separated from it with a sponge, leaving the design in the most perfect state. The ware is then dried, and taken to the oven to be burned; during this operation, the oil which has been mixed with the colour in the printing is destroyed, and the oxide of cobalt more firmly attached to the ware: it is then glazed.

*Glazing.*—The glaziers differ in their composition in all manufactories; most, however, have oxide of lead for their basis. The ingredients being mixed with water, and well ground, the glaze is ready for use, in which the vessels are dipped. On drying, which takes place instantly, the water contained in the glaze being absorbed by the porosity of the vessel, it is covered with a fine white powder of a regular thickness; this, when fired, becomes vitreous, or assumes a glass-like appearance, and from its transparency, the blue pattern underneath is rendered perfectly visible. In the last firing, especial care is taken to keep one piece from touching the other, or the whole would fuse into one united mass. Great attention is also requisite in the firing, not to give too much or too little heat, either extreme being injurious; the fireman in this, as in the other firing, draws out trial pieces from the oven, with an iron rod, to ascertain the proper degree of heat.

*Painting.*—The pieces of porcelain or earthenware to be enamelled and enriched by gilding are, after the first firing, dipped in a suitable glaze, and again submitted to the fire. They are then delivered to the painter or enameller. The colours used in enamel-painting are composed of metallic calxes, and fluxes suitable to each colour, separately and conjointly, and of such a nature as to fuse them sufficiently for the glazing on which they are laid. Gold has also its flux, and is laid on as the other colours are. When the painting is completed, the ware is placed in a furnace less in size, and different in construction, from that before noticed. Care is here necessary in the arrangement of the vessels, and great nicety is required in the degree and the continuation of the heat, which is not so intense as in the former firings. The colours, after this firing, put on a shining appearance, but the gold has an opaque yellow cast, and is burnished with a blood-stone, to give it the desired brilliancy.

The processes already detailed for the manufacture of earthenware, are applicable, in nearly every case, to that of porcelain. The composition of the bodies and glazes is, of course, different; and much greater care is necessary in every process, than is bestowed upon earthenware in general.

Delft ware, so called because first made at Delft, in Holland, is a kind of pottery of baked earth, covered with a white glazing, which gives it the appearance of porcelain. The basis of this pottery is clay mixed with a certain quantity of sand; the vessels are slightly baked, so that they resist a sudden application of heat; and they are, lastly, covered with an enamel or glaze, which is composed of common salt, sand ground fine, and the oxides of lead and tin. The latter gives a white opaque colour to the mass. The furnace and colours used for painting this ware, are the same as those which have been noticed as employed for porcelain. *See* Porcelain.

**POUNCE**, gum sandarach pounded and sifted very fine, to rub on paper, in order to preserve it from sinking, and to make it more fit to write upon. Pounce is also a little heap of charcoal dust, enclosed in a piece of muslin or some other open stuff, to be passed over holes pricked in a work, in order to mark the lines or designs on paper, silk, &c. placed underneath; which are to be afterwards finished with a pen and ink, a needle, or the like.

**POUND**, an English weight of different denominations, as, Avoirdupois, Troy, Apothecaries, &c. The pound avoirdupois is 16 ounces of the same weight, but the other pounds are each equal to 12 ounces. The pound avoirdupois is to the pound troy as 5760 to 6999½, or nearly as 576 to 700. *See* Measures.

Pound is also the highest denomination used by the English in their money accounts, being equal to 20 shillings.

**POURSUIVANT**, or Pursuivant, in Heraldry, the lowest order of officers at arms. The poursuivants are properly attendants on the heralds, when they marshal public ceremonies.

**POWDER** Chests, among sailors, certain small boxes charged with powder and old nails, &c. and fastened occasionally on the decks or sides of merchant-ships, when furnished with close-quarters, having a train of powder which communicates with the inner apartments, so as to be fired at pleasure to annoy the enemy. These chests are usually from 12 to 18 inches in length, and about 8 or 10 in breadth, having their outer or upper terminating in an edge. They are nailed to several places of the quarter-deck and bulk-head of the waist, having a train of powder which communicates with the inner apartments of the ship.

**POWER**, in Arithmetic and Algebra, that which arises by the successive multiplication of any number or quantity into itself, the degree of the power being always denominated by the number of equal factors that are employed; thus,

$2 =$ ..................... $2^1$, 1st power of 2.
$2 \times 2 =$ ................ $2^2$, 2d power or square.
$2 \times 2 \times 2 =$ .......... $2^3$, 3d power or cube.
$2 \times 2 \times 2 \times 2$ ........ $2^4$, 4th power,
&c. &c.

So also,

$x =$ ..................... $x^1$, 1st power.
$x \times x =$ ................ $x^2$, 2d power.
$x \times x \times x =$ .......... $x^3$, 3d power.
$x \times x \times x \times x$ ........ $x^4$, 4th power,
&c. &c.

Hence it appears, that the index which denotes the degree of any power, is always equal to the number of factors from which that power arises; or one more than the number of operations. *See* Exponent and Involution.

Power of the *Hyperbola*, is the fourth power of its conjugate axis.

Power, in Mechanics, denotes any force, whether of a man, a horse, a spring, the wind, water, &c. which being applied to a machine tends to produce motion.

Power is also used in Mechanics, for any of the six simple machines, *viz.* the lever, the balance, the screw, the wheel and axle, the wedge, and the pulley.

Power of a *Glass*, in Optics, is by some used for the distance between the convexity and the solar focus.

Power, in Law, is an authority which one man gives to another to act for him, and it is sometimes a reservation which a person makes in a conveyance for himself to do some acts, as to make leases or the like. 2 Lil. Abr. 339. Thus power of attorney, an instrument or deed whereby a person is authorized to act for another, either generally, or in a specific transaction.

Power of the county, called the *Posse Comitatus*, contains the aid and attendance of all knights, gentlemen, yeomen, labourers, servants, apprentices, and all others above the age of fifteen years within the county.

Power Loom. *See* Loom, p. 596.

**POZZOLANA**, in Natural History, is a kind of substance formed of volcanic ashes. When mixed with a small portion of lime it quickly hardens, and this induration takes place even under water. This singular property, of becoming petrified under water, renders it peculiarly valuable as a cement, in the erection of moles, and other buildings in maritime situations.

**PRACTICE**, is an Arithmetical rule, principally employed in those questions in which the amount of a certain number of things is required, the price of each being given; being a more ready and expeditious method than *Compound Multiplication*, by which rule the same questions may always be resolved.

Practice, is commonly divided into several cases, which by some authors are so much multiplied, as to become very burdensome to the memory, an inconvenience that more than counterbalances the advantages arising from this subdivision: in fact, the whole of the cases that are worth retaining, may be classed under the following heads:—

1. *When the price is less than a penny.*
2. *When the price is less than a shilling.*
3. *When the price is less than a pound.*
4. *When the price is more than a pound.*

And the general rule for all these cases is this:—*Rule.* Take such aliquot parts of the given number of things, as the given price is of the next superior denomination.—*Note.* In the last case, multiply first by the number of pounds; and for shillings, pence, and farthings, proceed by the above rule, and add the result to the preceding product.

*Examples.*

| | |
|---|---|
| ½d. = ½ | 4643 at ¾d. |
| ¼d. = ½ | 2321½ |
| | 1160¾ |
| 12 | 3482¼ |
| 2,0 | 29,0 2¼ |
| | £.14 10 2¼ *Ans.* |

| | |
|---|---|
| 4d. = ⅓ | 5648 at 4¾d. |
| ½d. = ⅛ | 1882 8 |
| ¼d. = ½ | 235 4 |
| | 117 8 |
| 2,0 | 223,5 8 |
| | £.111 15 8 *Ans.* |

| | |
|---|---|
| 5s. = ¼ | 4186 at 6s. 7½d. |
| 1s. = ⅕ | 1046 10 |
| 6d. = ½ | 209 6 |
| 1½d. = ¼ | 104 13 |
| | 26 3 3 |
| | £.1386 12 3 *Ans.* |

| | |
|---|---|
| 6s. 8d. = ⅓ | 7416 at 3l. 6s. 8d. |
| | 3 |
| | 22248 |
| | 2472 |
| | £.24720 *Ans.* |

The same method may be employed in weights and measures of every description, though the rule is generally limited to money concerns.

**PRÆCIPE**, a writ commanding the defendant to do the thing required, or to shew cause why he hath not done it.

**PRÆMUNIRE.** This punishment is inflicted upon him who denies the king's supremacy the second time; upon him who affirms the authority of the pope, or refuses to take the oath of supremacy; upon such as are seditious talkers of the inheritance of the crown; and upon such as affirm that there is any obligation by any oath, covenant, or engagement whatsoever, to endeavour a change of government either in church or state, or that both or either house of parliament have or has a legislative power, without the king, &c. The judgment in præmunire at the suit of the king, against the defendant being in prison, is, that he shall be out of the king's protection; that his lands and tenements, goods and chattels, shall be forfeited to the king; and that his body shall remain in prison at the king's pleasure; but if the defendant is condemned upon his default of not appearing, whether at the suit of the king or party, the same judgment shall be given as to the being out of the king's protection and the forfeiture; but instead of the clause that the body shall remain in prison, there shall be an award of a capiatur. Co. Lit. 129. Upon an indictment of a præmunire, a peer of the realm shall not be tried by his peers. 12 Co. 92.

**PRAGMATIC SANCTION**, in the Civil Law, is defined to be a rescript, or answer of the sovereign, delivered by advice of his council, to some college, order, or body of people, upon consulting him in some case of their community. The like answer given to any particular person, is called simply rescript.

**PRAM**, or **PRAME**, a sort of lighter used in Holland and the ports of the Baltic sea, for loading and unloading ships.

**PRATIC**, or **PRATIQUE**, a term used in the European ports of the Mediterranean sea, which implies the permission to trade and communicate with the natives of any place, after having performed the required quarantine.

**PRAYER**, in Theology, a petition put up to God for the obtaining of some future favour.

**PREBENDARY**, an ecclesiastic who enjoys a prebend. The difference between a prebendary and a canon is, that the former receives his prebend in consideration of his officiating in the church; but the latter merely by his being received into the cathedral or college.

**PRECEDENCE**, or **PRECEDENCY**, a place of honour to which a person is entitled; this is either of courtesy or of right. The former is that which is due to age, estate, &c. which is regulated by custom and civility: the latter is settled by authority, and when broken in upon gives an action at law.

**PRECEPT**, in Law, a command in writing sent by a chief justice, justice of the peace, &c. for bringing a person, record, or other matter, before him.

**PRECEPT**, is also used for the command or incitement by which one man stirs up another man to commit felony, theft, &c.

**PRECESSION** *of the Equinoxes*, which denotes that slow and imperceptible motion by which the equinoxes change their places, going backwards, or westward, contrary to the rest of the signs, may be thus explained. The fixed stars vary their right ascension and declination, but keep the same latitude; these variations are accounted for by supposing that the celestial sphere revolves round the pole of the ecliptic. Or, that the poles of the equator revolve round those of the ecliptic. And this revolution is called the precession of the equinoxes, because by it, the time and place of the sun's equinoxial station precedes the usual calculations. The ecliptic, the solstices, the equinoxes, and all the points of the ecliptic, are moving from Aries towards Pisces; *i. e.* from east to west. The equinoctial points are thence carried further back among the preceding signs or stars, at the rate of about one degree in 71 years and some few days. The annual precession is about 50″¼; that is, if the celestial equator cuts the ecliptic in a particular point on any day of this year, it will, on the same day of the following year, cut in a point 50″¼ to the west of its former intersection, and the sun will come to the equinox 20′ 23″ before he has completed his revolution of the heavens. Thus the equinoctial or tropical year, or true year of the seasons, is so much shorter than the revolution of the sun, or the sidereal year. The equinoctial points make a complete revolution in about 25,579 years, the equator being all the while inclined to the ecliptic in nearly the same angle. Therefore the poles of the diurnal revolution must describe a circle round the poles of the ecliptic at the distance of nearly 23½ degrees in 25,579 years. Hence the longitude, right ascension, and declination, of every star will be variable, and consequently the pole of the equinoctial cannot always be directed to the same star. In the time of Hipparchus the equinoctial points were fixed to the first stars of Aries and Libra; and the stars which were then in conjunction with the sun when he was in the equinox, are now a whole sign to the eastward of Aries. There are obviously then two zodiacs, a zodiac of the signs, moveable round the fixed zodiac and ecliptic. The precession of the equinoxes producing an annual increase of 50″¼ in the longitude of the fixed stars, makes exactly a degree in 71 years, 19 days, and 12 hours. Their right ascension varies from —60″ to + 143″ in certain stars round the pole. The annual increase in right ascension of others has been given as low as 5″, or about 15′ in 180 years. Their declinations vary from 20″ to 0″ annually *plus* or *minus*, or in 72 years from 24 minutes to 2′ 24″ *plus* or *minus*.

Astronomers have reckoned by the fixed and intellectual zodiac from a very early period; the Egyptians and Chaldeans reckoned according to the intellectual zodiac ages before Hipparchus made his discovery of the precession of the equinoxes. The first of their signs was *Taurus*. Hipparchus was the first among the Greeks, however, who established what is called a fixed zodiac; and he placed Aries at the first of the signs. This shews that the Greeks were in the habit of copying from the Egyptians in these matters; for the ram has nothing to do with Grecian mythology; on the contrary, it was the type of the Egyptian Ammon. In the Egyptian zodiac, by the second Hermes, Aries is represented as a man with ram's horns. The sun in this sign was worshipped as the god Ammon. This recession of Aries from the equinoctial point, and its occupation by Pisces has furnished some learned men with curious illustrations respecting the origin of the zodiacal signs, the mythology of the Greeks, the Egyptians, and Orientalists. In 365d. 6h. 49mi. the earth revolves round the sun, and during its progress in this annual course, it passes through the 12 signs of the zodiac successively. Hence we are accustomed to say the sun is in Aries, Taurus, &c. when in fact it is the earth that is in those signs, and the sun, as viewed from the earth, appears in the opposite part of its orbit.

*To find the Precession in right Ascension and Declination.*—Put $d =$ the declination of a star, and $a =$ its right ascension; then their annual variations, or precessions, will be nearly as follow, *viz.*

$20''084 \times \cos. a =$ the annual precession in declination,

and $46''\cdot0619 + 20''\cdot084 \times \sin. a \times \text{tang}. d =$ that of right ascension. See the *Connoissance des Temps* for 1792, p. 206.

**PRECIPITATE.** When a body, dissolved in a fluid, is either in whole or in part made to separate and fall down in the concrete state, this falling down is called precipitation, and the matter thus separated is called a precipitate.

**PREDIAL** TITHES, those which are paid of things arising and growing from the ground only, as corn, hay, fruit of trees, and the like.

**PREDICATE**, in Logic, that part of a proposition which affirms or denies something of the subject; thus, in these propositions, snow is white, ink is not white,—whiteness is the predicate which is affirmed of snow, and denied of ink.

**PREGNANCY**, to be with child. This is a plea in stay of execution, when a woman is convicted of a capital crime, alleging that she is with child; in which case the judge must direct a jury of twelve discreet women to inquire of the fact; and if they bring in their verdict "quick with child," execution shall be staid generally, until either she is delivered, or proves by the course of nature not to have been with child. 4 Black. 395.

**PREMISES**, is that part of the beginning of a deed, the office of which is to express the grantor and grantee, and the land or thing granted.

**PREROGATIVE**, is a word of large extent, including all the rights and privileges which by law the king has as chief of the commonwealth, and as intrusted with the execution of the laws.

PREROGATIVE *Court*, the court wherein all wills are proved, and all administrations taken which belong to the archbishop by his prerogative; that is, in case where the deceased has goods of any considerable value out of the diocese wherein he died; and that value is ordinarily *5l.* except it is otherwise by composition between the said archbishop and some other bishop, as in the diocese of London it is *10l.*

**PRESBYTERIANS**, a numerous and highly respectable sect of Protestants, so called from their maintaining that the government of the church appointed in the New Testament was by Presbyteries; that is, by ministers and ruling elders, associated for its government and discipline.

**PRESENTATION**, in Law, the act of a patron offering his clerk to be instituted in a benefice of his gift, the same being void.

**PRESENTMENT** OF OFFENCES, is that which the grand jury find to their own knowledge, and present to the court without any bill of indictment laid before them at the suit of the king; as, a presentment of a nuisance, a libel, and the like, upon which the officer of the court must afterwards frame an edictment before the party presented can be put to answer it. There are also presentments by justices of the peace, constables, surveyors of the highways, church-wardens, &c.

**PRESIDENT**, an officer created or elected to preside over a company, in contradistinction to the other members, who are called residents.

**PRESS**, a machine of wood or iron serving to squeeze any body very close. Presses usually consist of six pieces: two flat smooth planks, between which the things to be pressed are laid; two screws or worms fastened to the lower plank, and passing through two holes in the upper; and two nuts in the form of an S, that serve to drive the upper plank, which is moveable, against the lower, which is fixed. *See* BRAMAH'S MACHINE.

PRESSES *used for expressing Liquors*, are in most respects the same with the common presses, only the under plank is perforated with a great number of holes, for the juice to run through. Others have only one screw or arbor passing through the middle of the moveable plank, which descends into a kind of square box full of holes, through which the juices flow as the arbor is turned.

PRESS *used by Joiners*, to keep close the pannels, &c. of wainscot, consists of two screws and two pieces of wood, four or five inches square, and two or three feet long, whereof the holes at two ends serve for nuts to the screws.

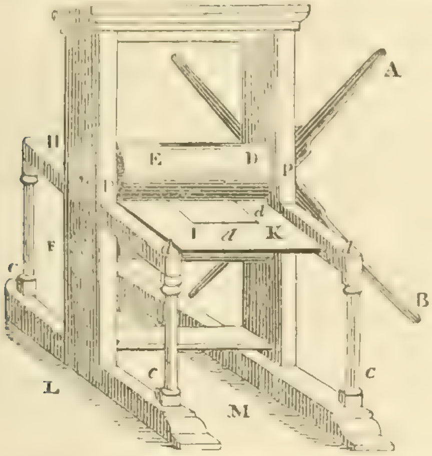
*Founders'* PRESS, is a strong square frame consisting of four pieces of wood firmly joined together with tenons, &c. It is of various sizes; two of them are required to each mould, at the two extremes whereof they are placed: so as that, by driving wooden wedges between the mould and sides of the press, the two parts of the mould for the metal may be pressed close together.

PRESS, *Binder's Cutting*, is a machine used equally by bookbinders, stationers, and pasteboard-makers; consisting of two large pieces of wood in form of cheeks, connected by two strong wooden screws; which, being turned by an iron bar draw together or set asunder the cheeks, as much as is necessary for the putting in the books or paper to be cut. The cheeks are placed lengthwise on a wooden stand in form a chest, into which the cuttings fall. Aside of the cheeks are two pieces of wood of the same length with the screws, serving to direct the cheeks, and prevent their opening unequally. Upon the cheeks the plough moves, to which the cutting knife is fastened by a screw; which has its key to dismount it, on occasion, to be sharpened. The plough consists of several parts; among the rest a wooden screw or worm, which catching within the nuts of the two feet that sustain it on the cheeks, brings the knife to the book or paper which is fastened in the press between two boards. This screw, which is pretty long, has two directories, which resemble those of the screws of the press. To make the plough slide square and even on the cheeks, so that the knife may make an equal paring, that foot of the plough where the knife is not fixed slides in a kind of groove, fastened along one of the cheeks. Lastly, the knife is a piece of steel, six or seven inches long, flat, thin, and sharp, terminating at one end in a point, like that of a sword, and at the other in a square form, which serves to fasten it to the plough. As the long knives used by us in the cutting of books or papers are apt to jump in the cutting thick books, the Dutch are said to use circular knives with an edge all round; which not only cut more steadily, but last longer without grinding.

PRESS, *Packing*. A very ingenious and useful packing press, invented by Mr. John Peck, procured for him in 1798, a reward from the Society of Arts. This machine consists of two very strong horizontal beams, one at the bottom for the bed, and the other at the top of the press. These are united by two iron screws, which stand in a vertical position, and therefore serve as cheeks to the press. The follower of this press is a very strong horizontal beam, having two nuts fitted into it at its ends. These nuts act upon the threads of the two vertical screws, and therefore it is plain, when they are turned round, that the follower will rise and fall accordingly. The nuts are so fitted into the follower, as to admit of a circular motion round the screw, but are not permitted to rise or fall without the follower. To give them motion, the edges of the circular rings are cut into cogs or teeth, and are turned by means of an endless screw for each, situated at the opposite ends of the horizontal spindle, which revolves in bearings attached to the follower of the press. The spindle has a winch at each end, by turning which the two endless screws act upon the wheels or teeth of the nuts, and by thus causing them to turn round with equal velocities, raises or depresses the follower always parallel to itself, and also to the head and bottom bed. The great utility of this press consists in its being capable of packing two sets of bales at once, thus answering the purpose of two presses, with more expedition, and less room. It is placed on the floor of the warehouse, and behind it a stage is erected, just half the height of the whole press. One set of bales is then made up on the floor, and the other upon the stage. Suppose the follower raised up above the level of the stage, a bale of goods is then placed on the lower bed, and by turning the winches the follower is forced down upon it, and remains there till it is sufficiently pressed. While the men are tying up this bale below, others on the stage are loading the follower, and the winches being turned, the former bale is released, and the latter receives the pressure. By these means, no time is lost in screwing up or opening the press, since it performs work in both ways.—The Philosophical Transactions for 1781, contains an account of a double screw applied to a press by Mr. W. Hunter. Its power is considerable, but a minute description will occupy too much of our room.

PRESS, *Copperplate Printing*. In addition to the presses already noticed, although many others, adapted to particular purposes, are in use, the copperplate printing press demands a distinct description. This machine, of which a representation is given in the following figure, consists, like the common printing presses, (for which see PRINTING,) of a body and a carriage.

The body consists of two cheeks, PP, of different dimensions, ordinarily about four feet and a half high, a foot thick, and two and a half apart, joined at top and bottom by cross pieces. The cheeks are placed perpendicularly on a wooden stand or foot, L M, horizontally placed, and sustaining the whole press. From the foot likewise rise four other perpendicular pieces, *c, c, c, c*, joined by other cross or horizontal ones, *d, d, d*, which may be considered as the carriage of the press, as serving to sustain a smooth, even plank, H I K, about 4½ feet long, 2½ feet broad, and 1½ inch thick; upon which the engraven plate is to be placed. Into the cheeks go two wooden cylinders or rollers D E, F G, about six inches in diameter, borne up at each end by the cheeks, whose ends, which are lessened to about two inches diameter, and called *trunnions*, turn in the cheeks between two pieces of wood, in form of half moons, lined with polished iron, to facilitate the motion. The space in the half moons, left vacant by the trunnion, is filled with paper, pasteboard, &c. that they may be raised and lowered at discretion; so as only to leave the space between them necessary for the passage of the plank charged with the plate, paper, and blankets. Lastly, to one of the trunnions of the upper roller is fastened a cross, consisting of two levers A B, or pieces of wood, traversing each other. The arms of this serve in lieu of the handle of the common press, giving a motion to the upper roller, and that to the under one; by which means the plank is protruded, or passed between them.



The practice of printing from copper-plates is nearly as follows:—The workmen take a small quantity of the ink on a rubber made of woollen rags, strongly bound about each other, and with this smear the whole face of the plate as it lies on a grate heated by a charcoal fire, or steam. The plate being sufficiently inked, they first wipe it over with a foul rag, then with a cleaner one, and lastly with the palm of their left and right hand, and to dry the hand and forward the wiping, they rub it from time to time on whiting. The address of the workman consists in wiping the plate perfectly clean, without taking the ink out of the engraving. The plate thus prepared is laid on the plank of the press; over the plate is laid on the paper, first well-moistened to receive the impression; and over the paper two or three folds of flannel. Things being thus disposed, the arms of the cross are pulled, and by that means the plate, with its furniture, is passed through between the rollers, which pinching very strongly, yet equally, presses the moistened paper into the strokes of the engraving, whence it takes out the ink; and receives the engraved impression.

*Perkins' Copperplate Presses.*—The press for which this celebrated engineer and artist has obtained a patent, differs not in principle from that already described, although it varies considerably in several particulars. The levers or spokes, instead of extending from the pinion of the roller to the hand of the pressman, terminate in an iron circumference, which forms a wheel, on the outer surface of which numerous handles are inserted, resembling those fixed in the wheels by which ships are steered. By these means, when the wheel is put in motion, the momentum obtained, renders the resistance which the roller receives while passing over the plate almost imperceptible. The roller, having a section cut off longitudinally, performs its work with the circular part only, on which account the limits of the impression must always be determined by the extent of its convexity. Unless, therefore, the roller be made very large, this press is better adapted for small plates than large ones. The plate having received its ink and paper, is presented to the roller, which, by turning the wheel, begins its work at the commencement of its convex surface, and passes on until the flat part turns downward. At this instant the impression ceases, the blanket which had been drawn in between the paper on the plate, and the roller, regains its original state of tension, the plate is released, and returns on its carriage to the workman, delivering up its paper, and is ready to be charged for another impression. It must be obvious from hence, that the paper never receives from the press a double impression, but is taken off like proof prints in the common way.

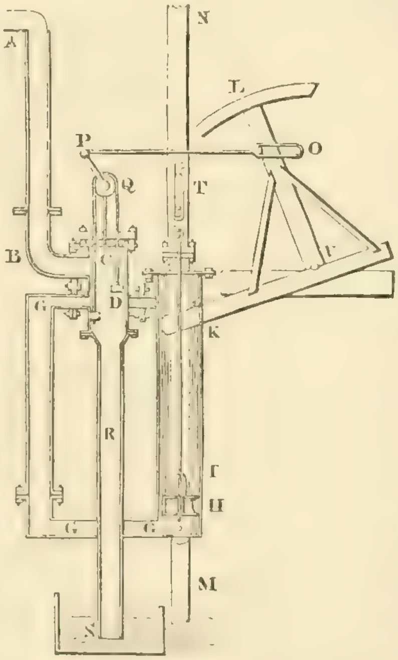
PRESS of Sail, signifies as much sail as the then state of the wind, &c. will permit a ship to carry.

PRESSED-MAN, one who has been impressed into the king's service, in contradistinction to a volunteer.

PRESS-GANG, a detachment of seamen, who (under the command of a lieutenant) are empowered, in time of war, to take any seafaring men, and oblige them to serve on board the king's ships.

PRESSING, in the Manufactures, is the violently squeezing a cloth, stuff, &c. to render it glossy.

PRESSURE Engines, for raising water by the pressure and descent of a column enclosed in a pipe, have been lately erected in different parts of this country. The principle now adverted to, was adopted in some machinery constructed in France about 1731, (see *Belidor de Arch. Hydraul*, lib. 4. ch. 1.) and was likewise adopted in Cornwall about fifty years ago. But the pressure-engine, of which we are about to give a particular description, is the invention of Mr. R. Trevithack, who probably was not aware that any thing at all similar had been attempted before. This engine, a section of which, on a scale of a quarter of an inch to a foot, as shewn in the annexed figure, was erected a few years ago at the Druid Copper Mine, in the parish of Illogan, near Truro. A B represents a pipe six inches in diameter, through which water descends from the head to the place of its delivery, to run off by an adit at S, through a fall of 34 fathoms in the whole; that is to say, in a close pipe, down the slope of a hill 200 fathoms long, with 26 fathoms fall; then perpendicularly six fathoms, till it arrives at B, and thence through the engine from B to S two fathoms. At the turn B the water enters into a chamber C, the lower part of which terminates in two brass cylinders, four inches in diameter; in which two plugs, or pistons of lead, D and E, are capable of moving up and down by their piston rods, which pass through a close packing above, and are attached to the extremities of a chain leading over, and properly attached to the wheel Q, so that it cannot slip.



The leaden pieces D and E are cast in their places, and have no packing whatever. They move very easily; and if at any time they should become loose, they may be spread out by a few blows with a proper instrument, without taking them out of their place. On the sides of the two brass cylinders, in which D and E move, there are square holes communicating towards F and G, which is a horizontal trunk or square pipe, four inches wide and three inches deep. All the other pipes G, G, and R, are six inches in diameter, except the principal cylinder wherein the piston H moves; and this cylinder is ten inches in diameter, and admits a nine-feet stroke, though it is here delineated as if the stroke were only three feet.

The piston rod works through a stuffing-box above, and is attached to M N, which is the pit rod, or a perpendicular piece divided into two, so as to allow its alternate motion up and down, and leave a space between, without touching the fixed apparatus, or great cylinder. The pit rod is prolonged down into the mine, where it is employed to work the pumps, or if the engine were applied to millwork, or any other use, this rod would form the communication of the first mover. K L is a tumbler, or tumbling-bob, capable of being moved on the gudgeons V, from its present position to another, in which the weight L shall hang over with the same inclination on the opposite side of the perpendicular, and consequently the end K will then be as much elevated as it is now depressed. The pipe R S has its lower end immersed in a cistern, by which means it delivers its water without the possibility of the external air introducing itself; so that it constitutes a torricellian column, or water barometer, and renders the whole column from A to S effectual; as we shall see in our view of the operation.

*The Operation.*—Let us suppose the lower bar K V of the tumbler to be horizontal, and the rod P O so situated, as that the plugs or leaden pistons D and E shall lie opposite to each other, and stop the waterways C and F. In this state of the engine, though each of these pistons is pressed by a force equivalent to more than a thousand pounds, they will remain motionless, because these actions being contrary to each other, they are constantly in equilibrio. The great piston H being here shewn, as at the bottom of its cylinder, the tumbler is to be thrown by hand into the position here delineated. Its action upon O P, and consequently upon the wheel Q, draws up the plug D, and depresses E, so that the water-way G becomes open from A B, and that of F to the pipe R; the water consequently descends from A to C; thence to G G G, until it acts beneath the piston H. This pressure raises the piston, and if there be any water above the piston, it causes it to rise and pass through F into R. During the rise of the piston (which carries the pit rod M N along with it,) a sliding block of wood I, fixed to this rod, is brought into contact with the tail K of the tumbler, and raises it to the horizontal position, beyond which it oversets by the acquired motion of the weight L.

The mere rise of the piston, if there were no additional motion in the tumbler, would only bring the two plugs D and E to the position of rest, namely, to close G and F, and then the engine would stop; but the fall of the tumbler carries the plug D downwards quite clear of the hole F, and the other plug E upwards, quite clear of the hole G. These motions require no consumption of power, because the plugs are in equilibrio, as was just observed. In this new situation, the column A B no longer communicates with G, but acts through F upon the upper part of the piston H, and depresses it; while the contents of the great cylinder beneath that piston are driven out through G G G, and pass through the opening at E into R. It may be observed, that the column which acts against the piston is assisted by the pressure of the atmosphere, rendered active by the column of water hanging in R, to which that assisting pressure is equivalent, as has already been noticed.

When the piston has descended through a certain length, the slide or block at T, upon the piston rod, applies against the tail K of the tumbler, which it depresses, and again oversets; producing once more the position of the plugs D E, here delineated, and the consequent ascent of the great piston H, as before described. The ascent produces its former effect on the tumbler and plugs; and in this manner it is evident, that the alterations will go on without limit; or until the manager shall think fit to place the tumbler and plugs D E in the positions of rest; namely, so as to stop the passages F and G. The length of the stroke may be varied by altering the position of the pieces T and I, which will shorten the stroke the nearer they are together; as in that case, they will sooner alternate upon the tail K. As the sudden stoppage of the descent of the column A B, at the instant when the two plugs were both in the waterway, might jar and shake the apparatus, those plugs are made half an inch shorter than the depth of the side holes; so that in that case, the water can escape directly through both the small cylinders to it. This gives a moment of time for the generation of the contrary motion in the piston and the water in G G G, and greatly deadens the concussion, which might else be produced.

Some former attempts to make pressure engines upon the principle of the steam-engine, have failed; because water, not being elastic, could not be made to carry the piston onwards a little, so as completely to shut one set of valves and open another. In the present judicious construction, the tumbler performs the office of the expansive force of steam at the end of the stroke.

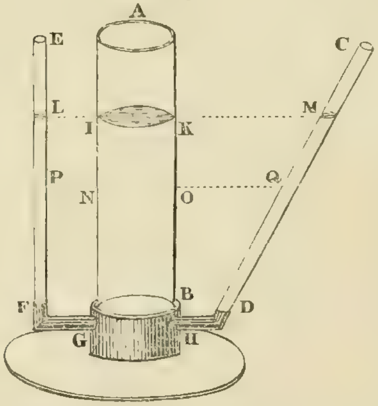
Mr. Boswell suggests, as a considerable improvement, that the action of this engine should be made elastic by the addition of an air-chamber, on the same principle as that used in fire-engines; this, he thinks, might be best effected by making the piston hollow, with a small orifice in the bottom, and of a larger size, to serve for this purpose, as the spring of the air would then act both on the upward and downward pressure of the water.

Pressure, in Physics, is properly the action of a body, which makes a continual effort or endeavour to move another body on which it rests; such as the action of a heavy body supported by a horizontal table, and is thus distinguished from percussion or momentary force of action. Since action and reaction are equal and contrary, it is obvious that pressure equally relates to both bodies, *viz.* the one which presses, and that which receives the pressure. See a few remarks on the difference between percussion and pressure, under the article Percussion.

Pressure of *Fluids*, is of two kinds, *viz.* of elastic and non-elastic fluids.

Pressure of *Non-elastic Fluids.* The upper surface of a homogeneous heavy fluid in any vessel, or any system of communicating vessels, is horizontal.

*Fig.* 1.



This is a matter of universal experience; and, as it is easily observed, may be taken for the distinguishing property of fluids. Thus, if A B C D E F, fig. 1, be a vessel in which the branches C D H, E F G, have a free communication with the part A B; then if water, or mercury, or wine, or any other fluid commonly reckoned non-elastic, be poured in either at A, C, or E, and when the whole is at rest, the surface of the fluid stands at I K in the larger trunk; if the line L I K M be drawn parallel to the horizon, the surface of the fluid will stand at L in the branch E F, and at M in the branch C D; and this whatever are the inclinations of those branches, or the angles at F and D, G and H.

This is usually explained by saying, that since the parts of a fluid are easily moveable in any direction, the higher particles will descend, by reason of their superior gravity, and raise the lower parts till the whole comes to rest in a horizontal plane. Now, what is called the horizontal plane is, in fact, a portion of a spherical surface, whose centre is the centre of the earth: hence it will follow, that if a fluid gravitate towards any centre, it will dispose itself into a spherical figure, the centre of which is the centre of force.

*Prop.* If a fluid, considered without weight, is contained in any vessel whatever, and, an orifice being made in the vessel, any pressure whatever be applied thereto, that pressure will be distributed equally in all directions.

Through any point N, fig. 1, taken at pleasure below the surface of the fluid L I K M, imagine the horizontal plane P N O Q to pass. It is obvious, the weight of the fluid contained in the vessel below P N O Q, contributes nothing to the support of the columns L P, I O, M Q, so that the equilibrium would obtain in like manner, if the fluid contained in that part of the vessel below P N O Q had lost its weight entirely. We may, therefore regard this fluid as being solely a mean of communication between the columns L P, I O, M Q; in such manner that it will transmit the pressure resulting from the columns L P, M Q, to the column I O, and reciprocally. If now, instead of the columns L P, I O, M Q, of the fluid, pistons were applied to the surfaces P, N, O, and Q, and were separately urged by pressures respectively equal to the pressures of the columns L P, I O, M Q, the equilibrium would manifestly obtain in like manner. Or if a pressure, equal that of the column M Q, be applied at Q, while the columns L P, I O, remain, the equilibrium will still obtain; and this, whatever are the directions of the several branches, and their sinuosities at D, F, &c. whence the proposition is evident.

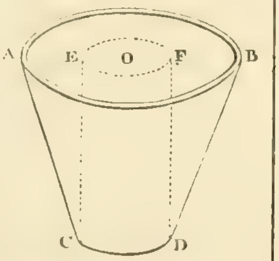
*Cor.* 1. Not only is the pressure transmitted equally in all directions, but it acts perpendicularly upon every point of the surface of the vessel which contains the fluid.

For, if the pressure which acts upon the surface were not exerted perpendicularly, it is easy to see that it could not be entirely annihilated by the reaction of that surface; the surplus force would, therefore, occasion fresh action upon the particles of the fluid, which must be transmitted in all directions, and occasion a motion in the fluid; that is, the fluid could not be at rest in the vessel, which is contrary to experience.

*Cor.* 2. Hence also, if the parts of a fluid, contained in any vessel A B C D, open towards the part A B, are solicited by any forces whatever, and remain, notwithstanding, in equilibrio, these forces must be perpendicular to the surface A B. For the equilibrium would obtain, if a cover or a piston of the same figure as the surface A B, were applied to it; and it is manifest, that in this case, the forces which act at the surface, or their resultant, must be perpendicular to that surface.

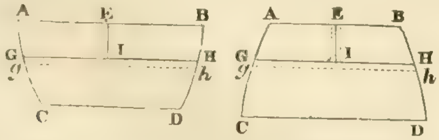
*Cor.* 3. If, therefore, the forces which act upon the particles of the fluid are those of gravity, the direction of gravity is perpendicular to the surface of a tranquil fluid; consequently, the surface of a heavy fluid, to be in equilibrio, must be horizontal, whatever may be the figure of the vessel in which it is contained.

*Cor.* 4. If a vessel, as A B C D, closed throughout, except a small orifice O, is full of a fluid without weight, then if any pressure be applied at O, the resulting pressure on the plane surface or bottom C D, will neither depend upon the quantity of fluid in the vessel, nor on its shape; but since the pressure applied at O, is transmitted equally in all directions, the actual pressure upon C D will be to the pressure at O, as the area of C D is to that of the orifice.

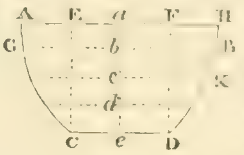


*Cor.* 5. In the same manner will the pressure applied at O be exerted in raising the top A B of the vessel; so that if the top be a plane, of which O forms a part, the vertical pressure tending to force A B upwards, will be to the force applied at O, as the surface A B to the area O. *See* Hydrostatic *Bellows*.

**Prop.** The pressure of a fluid on the horizontal base of a vessel in which it is contained, is as the base and perpendicular altitude, whatever be the figure of the vessel that contains it; the upper surface of the fluid being supposed horizontal.



Let any horizontal plane, G H, be supposed drawn, and conceive the fluid contained in the part G C D H of the vessel to be void of weight; then, as it is evident, from cor. 3 of the foregoing proposition, that any vertical filament whatever, E I of the heavy fluid A B H G, exerts at the point I a pressure, which is distributed equally through the fluid G C D H; and that this pressure acts equally upwards to oppose the action of each of the other filaments which stand vertically above G H; therefore, the filament E I alone keeps in equilibrio all the other filaments of the mass A G H B; consequently, the mass G C D H being still supposed without weight, there will not result any other pressure on the bottom C D than that of a single filament E I; which, being transmitted equally to all the points of C D, will make the pressure upon C D to that upon the base I of the filament E I, as the area of C D to the area I. If, therefore, we imagine a heavy fluid contained in A C D B, to be divided into horizontal laminæ, the upper lamina will communicate to the bottom C D, no other action than would be communicated by the single filament *a b*; and the same thing obtaining with respect to each lamina, the bottom therefore is pressed in the same degree as it would be by the combined operation of the filaments *a b*, *b c*, *c d*, &c. Whence, as this pressure is transmitted equally to all points of C D, it will be equal to the product of C D into the sum of the pressures which the filaments *a b*, *b c*, *c d*, are capable of exercising on the same point, or it will be proportional to C K × $(ab + bc + cd +$, &c.).—*Gregory's Mechanics*, article 384, &c.



*Centre* of Pressure. *See* Centre.

PREVARICATION, in the Civil Law, is where the informer colludes with the defendants, and so makes only a sham prosecution.

PREVENTER, in naval language, an additional rope employed at times to support any other, when the latter suffers an unusual strain, particularly in a strong gale of wind. *Preventer-brace*, a temporary brace, fixed occasionally to succour the main or fore yard, or to supply the place of the usual braces, in the event of their being shot away in action. *Preventer-stay*, is a smaller stay, fixed above the standing one, and serves to relieve the latter, or to supply its place. *Preventer-shrouds*, are applied to serve the same purposes.

PRICE, Dr. Richard, a celebrated English mathematician, fellow of the Royal Society, and of the Academy of Sciences, New England, was born at Tynton, in Glamorganshire, in 1723, and died in London, in 1791, in his sixty-eighth year.

PRICK, in seafaring language, is a term applied to a roll of small rope, &c. as a prick of spun yarn, a prick of tobacco.

PRICKING, in the sea language, is to make a point on the plan or chart, near about where the ship then is, or is to be at such a time, in order to find the coure they are to steer.

Pricking *a Chart*, the act of tracing a ship's course upon a marine chart, by the help of a scale and compasses, so as to discover her present situation. *Pricking a Sail*, is the running a middle seam between the two seams which unite every cloth of a sail to the next adjoining, and is rarely performed till the sails have been worn some time.

PRIMÆVIÆ, among Physicians, denote the whole alimentary duct; including the œsophagus, stomach, and intestines, with their appendages.

PRIMARY ROCKS, are so called by the Wernerians, because therein no organic remains have been found, hence it is supposed they were formed prior to the creation of animals or vegetables. The are extremely hard, and their substances are pure crystallized matter, in large vertical masses, more or less inclined to the horizon, and without fragments, or other rocks. They form the lowest part of the earth's surface with which we are acquainted; and not only constitute the foundation on which the other rocks rest, but in many situations pierce through the incumbent rocks and strata, and form the highest mountains in alpine districts.

Primary *Planets*, are such as revolve about the sun as a centre; such are Mercury, Venus, Terra the Earth, Mars, Vesta, Juno, Pallas, Ceres, Jupiter, Saturn, and Uranus or the Georgium Sidus; being thus called in contradistinction to the secondary planets or satellites, which revolve about their respective primaries. *See* Planet.

PRIMALTES, in Natural History, the first order of mammalia in the Linnæan system. The animals in this order are furnished with fore-teeth or cutting-teeth: the four above are parallel; two breasts on the chests. There are four genera, *viz.* Homo, Lemur, Simia, Vespertilio.

**PRIMING**, or **Prime** of a **Gun**, is the gunpowder put into the pan or touch-hole of a piece to give it fire thereby; and this is the last thing done in charging. For pieces of ordnance they have a pointed iron rod, to pierce the cartridge through the touch-hole, called primer or priming-iron.

**PRIME Numbers**, are those which have no divisors, or which cannot be divided into any number of equal integral parts, less than the number of units of which they are composed; such as 2, 3, 5, 7, 11, 13, 17, &c. These numbers have formed a subject of investigation and inquiry from the earliest date down to the present day; and a rule for finding them is still amongst the desiderata of mathematicians. The method of finding a prime number beyond a certain limit, by a direct process, is considered one of the most difficult problems in the theory of numbers; which, like the quadrature of the circle, the trisection of an angle, and the duplication of the cube, have engaged the attention of many able mathematicians, but without arriving at any satisfactory result.

**Prime** *Vertical*, is that vertical circle, or azimuth, which is perpendicular to the meridian, and passes through the east and west points of the horizon.

**Prime** *Verticals*, in Dialling, or **Prime** *Vertical Dials*, are those that are projected on the plane of the prime vertical circle, or on a plane parallel to it. These are otherwise called direct, erect, north, or south dials.

**Prime** of the *Moon*, is the new moon at her first appearance, for about three days after her change. It means also the Golden *Number*, which see.

**PRIMULA Officinalis.** (*The Cowslip.*) The flowers appear in April; they have a pleasant sweet smell, and a subacrid, bitterish, subastringent taste. An infusion of them, used as tea, is recommended as a mild corroborant in nervous complaints. A strong infusion of them, with a proper quantity of sugar, forms an agreeble syrup, which for a long time maintained a place in the shops. By boiling, even for a little time, their fine flavour is destroyed. A wine is also made of the flowers, which is given as an opiate.

**PRIMUM Mobile**, in the Ptolemaic Astronomy, the ninth or highest sphere of the heavens, whose centre is that of the world, and in comparison of which the earth is but a point. This the ancients supposed to contain all other spheres within it, and to give motion to them, turning itself, and all of them, quite round in twenty-four hours.

**PRINCE**, a person invested with the supreme command of a state.

**Prince's** *Metal*, a mixture of copper and zinc, in imitation of gold.

**PRINCIPAL**, in Arithmetic or in Commerce, is the sum lent upon interest, either simple or compound. *See* Interest.

**Principal** and *Accessary*, in Criminal Law, principal is the person who himself commits the offence. An accessary is a person who participates by advice, command, or concealment. There are two kinds of accessaries; before the fact, and after it. The first is he who commands or procures another to commit felony, and is not present himself; for if he be present, he is a principal. The second is he who receives, assists, or comforts any man that has done murder or felony, whereof he has knowledge. A man may be accessary to an accessary, by aiding, receiving, &c. an accessary in felony. An accessary in felony before the fact, shall have judgment of life and member, as well as the principal who did the felony: but not till the principal be first attainted, and convicted or outlawed thereon. Where the principal is pardoned without attainder, the accessary cannot be arraigned; it being a maxim in law, Ubi non est principalis, non potest esse accessorius. But if the principal be pardoned, or have his clergy after attainder, the accessary shall be arraigned. 4 and 5 W. and M. cap 4; and by stat. 1 Anne, cap. 9, it is enacted, that where the principal is convicted of felony, or stands mute or challenges above twenty of the jury, it shall be lawful to proceed against the accessary in the same manner as if the principal had been attainted; and notwithstanding such principal shall be admitted to his clergy, pardoned or delivered before attainder. In some cases also, if the principal cannot be taken, then the accessary may be prosecuted for a misdemeanor, and punished by fine, imprisonment, &c. stat. ib. see stat. 5 Anne, cap. 31. In the lowest and highest offences there are no accessaries, but all principals: as in riots, routs, forcible entries, and other trespasses, which are the lowest offences. So also in the highest offence, which is according to our law high treason, there are no accessaries.—Coke.

**PRINGLE, Sir John**, a very distinguished physician and philosopher, was born in Roxburghshire in 1707, and took his degree of M.D. at Leyden in 1730; and there published his "Dissertatio de Marcore Senili," in 4to. In 1766 he was elected President of the Royal Society, an honour which he resigned in 1778, and died in 1782.

**PRINT**, the impression taken from a copper-plate.

**PRINTING**, in its general signification, is the art of taking impressions from characters or figures, moveable or immoveable, on paper, vellum, linen, silk, &c.. Of printing, there are four kinds; one, from plates of copper or steel for pictures, (see *Copperplate Printing*); another, from blocks, in which birds, flowers, &c. are cut for linen, (see *Calico Printing*); a third, from solid metal pages, cast for the printing of books, (see *Stereotype*); and finally, as of more importance than either, from moveable letters, to which the world is so much indebted for the treasures of literature with which it is enriched.

It is somewhat remarkable, that while the art of Letterpress Printing has formed a new era in the history and character of man, the origin of its invention is involved in mysterious obscurity. The primitive honour of having given birth to this sublime vehicle of knowledge, has been claimed by Mentz, Strasburg, Harlem, Dordrecht, Venice, Rome, Florence, Basle, and Augsburg. Harlem, Mentz, and Strasburg are, however, the only places that can advance formidable reasons in favour of their respective claims; but the decision of this much disputed question lies not within the province of this work.

It is admitted by all parties, that this important invention took place about the year 1440, and was brought to England by William Caxton, who set up his first press in Westminster Abbey, and began to print books soon after the year 1471. Since that period, considerable improvements have been made in various branches of the art, but more particularly so in the construction of presses, the increase and application of power, the diminution of manual labour, and the facilities given to expedition.

In the early days of printing, the presses were invariably made of wood, and in general construction bore a strong resemblance to those now in use. The representation of one bearing the date of 1560, is now before us, and its appearance is not essentially different from the improved wood press, in the annexed figure, which we proceed to describe. See the Plate *Printing Presses.*

The body of the press, fig. 1, consists of two strong posts, *b*, called the cheeks, placed perpendicular, and joined together by four horizontal cross pieces; the upper of these, *a*, is called the cap, and has no office but to retain the two cheeks at their required distances, and support the heads; the next cross piece, *c*, is called the head; it is fitted by tenons at the ends into mortises between the cheeks, and these mortises are filled up with pieces of pasteboard or soft wood, in such a manner as to admit of a small motion or yielding. The head is sustained by two long screw-bolts, which suspend it from the cap: in the head is fixed a brass nut, containing a female screw or worm, which is fastened in the wood by two short bolts to keep it up: the worm is adapted to receive the screw by which the pressure is produced. The third cross piece, *e*, called the shelves, or till, is to guide and keep steady a part, *i*, called the hose, in which the spindle of the screw (to be spoken of hereafter) is enclosed. The fourth cross plank, *f*, called the winter, is fitted between the cheeks to bear the carriage; it sustains the effort of the press beneath, as the head does above, each giving way a little, the one upwards, the other downwards, to make the pull the easier. The spindle, *g*, is an upright piece of iron, pointed at the lower end with steel, having a male screw formed on its upper end, which enters about four inches into the female screw or worm fixed in the head: through the eye of this spindle is fixed the bar or handle, *h*, by which the pressman works the

# Printing Presses

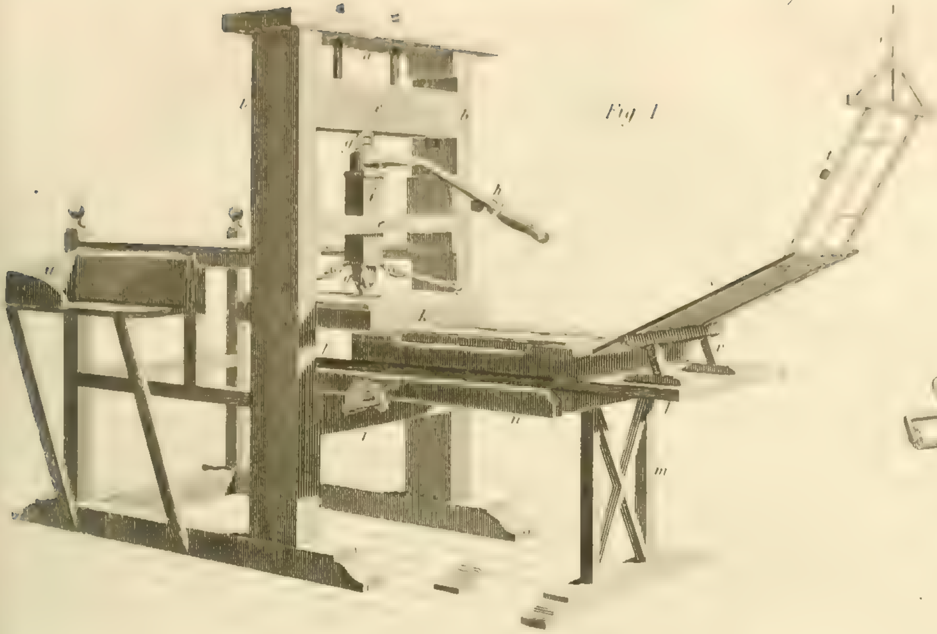


Fig 1

Fig.

Fig. 4.

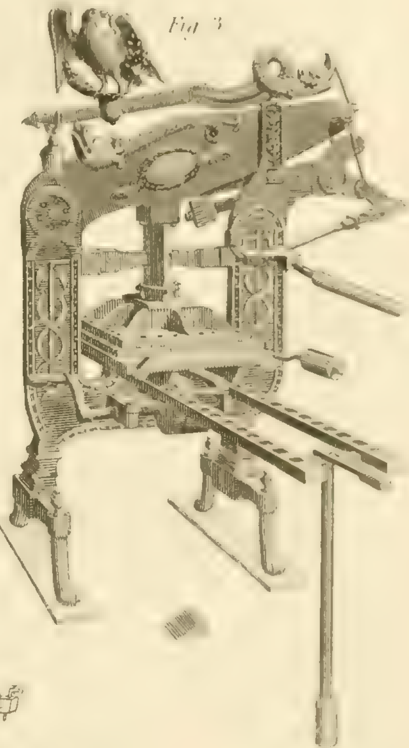


Fig 3

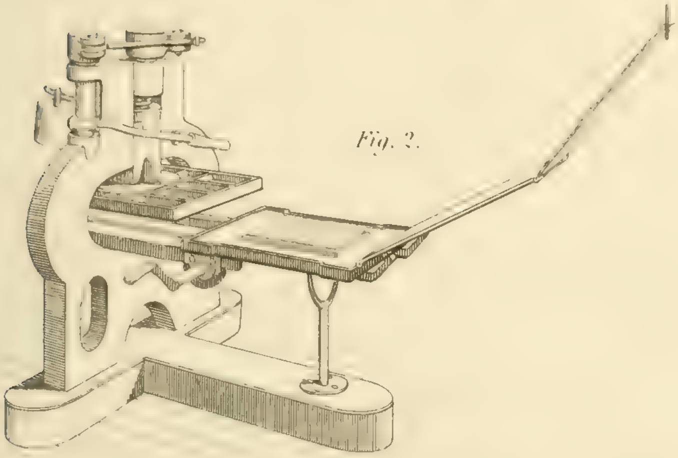


Fig. 2.

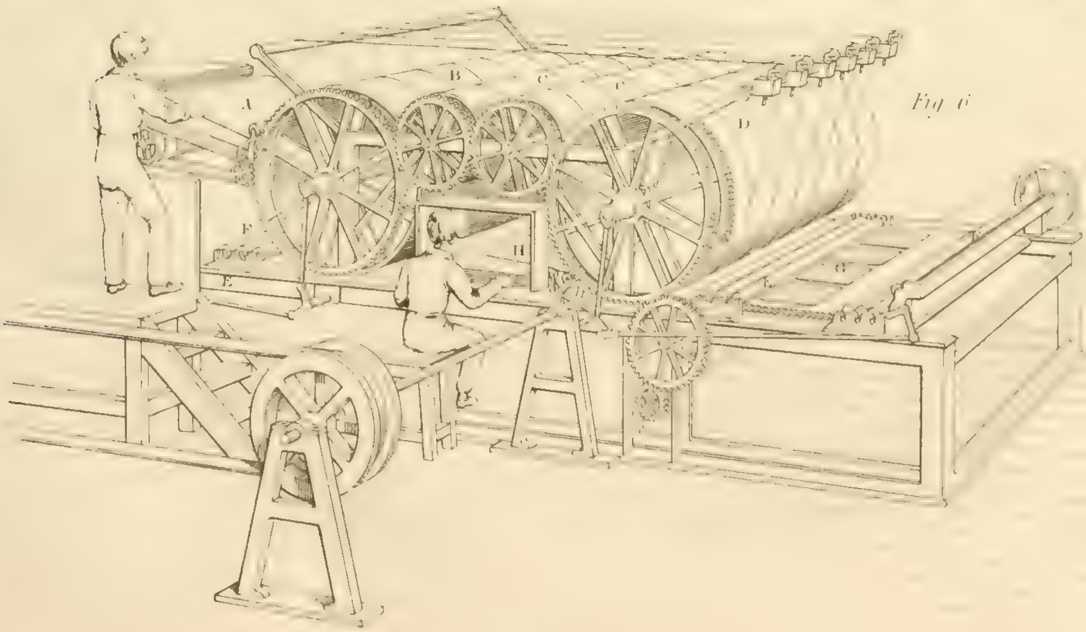


Fig 6

press. The platen, *k*, or surface which acts upon the paper to produce the impression, is suspended from the point of the spindle by means of a square block or frame of wood, *i*, called the hose, which is guided by passing through the shelves, *e e*: the lower part of the spindle passes through the hose, and its point rests upon the platen *k*, being received into the plug fixed in a brass pan supplied with oil, which pan is fixed to an iron plate let into the top of the platen *k*. The pressman then, by pulling the bar *h*, fixed in the eye of the spindle *g* by an iron key, turns the spindle, and by means of its screw presses down the platen upon the form of types, which is covered with the paper, tympan, and its blankets, all these parts being brought under the platen by the carriage, when the impression is to be given. That the platen may be suspended from the spindle, and rise up again with it, the hose, *i*, is attached to the spindle by the garter; this is a fillet of iron screwed to the hose, and entering into a nick or groove formed round the upper part of the spindle; it prevents the hose falling down on the spindle. At each corner of the lower part of the hose there is an iron hook fastened, and from these to similar hooks, fastened at each corner of the platen *k*, cords or packthread are looped to suspend the platen, and they are exactly adjusted, to hang the platen truly level.

The carriage *l*, which is the other principal part of the press, is adapted to run into the space between the cheeks under the platen. It is supported upon the ribs *n*, which are part of a horizontal wooden frame, having its fore-part supported by a wooden prop *m*, called the fore-stay, while the other end rests on the winter. On the rails of this frame two long iron bars or ribs are nailed, and under the plank of the carriage are nailed short pieces of iron or steel, called cramp irons, which slide upon the ribs, when the carriage is run in or out, by the following means. Beneath the carriage is placed a small spindle called the spit, with a double wheel formed in the middle of it, round which leather girths are passed and fastened, the opposite ends being nailed to each end of the plank *l* of the carriage. On the extreme end of the spit is fixed the handle or rounce by which the pressman turns the spit, and this, by by means of the wheel and straps, runs the carriage in or out at pleasure. The carriage itself consists of a strong wooden plank *l*, upon which a square frame of wood is fixed, to form the coffin or cell, in which a marble or polished stone is enclosed, for the form of the types to be laid upon. To this coffin are fastened leather stay-girths, one to each end, which being at the opposite ends fastened to the horizontal frame, prevent the carriage running too far out, when drawn from under the platen. On the fore-part of the plank is a gallows *r*, which serves to sustain the tympans, when turned up from off the form, on their hinges. The tympans, *s*, are square frames covered with parchment. The frames are made of three slips of very thin wood, and at the top a slip of iron, still thinner, called a head-band. The two tympans are fitted together by the frame of one being small enough to lie within the other: the outward tympan is fastened with iron hinges to the coffin. Between the two parchments of the tympans one or two thicknesses of blankets are placed, which serve to make the impression of the platen upon the surface of the letters more equal, as also to prevent the letters from being broken by the force of the press. The use of the inner tympan is, to confine these blankets. The frisket *t*, is a square frame of iron, made very thin, also covered with paper or parchment, and fastened to the head-band of the outer tympan by hinges: it folds down upon the tympan, to enclose the sheet of paper between them, the parchment or paper with which the frisket is covered being cut out in the necessary places, that the sheet, when placed between the tympan and frisket, and both together folded down on the form, may receive the ink from the types in the pages; but the frisket sheet keeps the margins clean. The tympan and frisket, when folded down, lie flat upon the form, and the carriage with them is run into the press; but when the sheet is to be taken out, the tympan is lifted up upon its hinges, and rests as represented, in an inclined position against the gallows *r*, before mentioned, at the back part of the carriage; then the frisket *t* is lifted up on its hinges, and sustained by a slip of wood *w*, hanging from the ceiling, whilst it continues open, to take out the printed sheets and put in others.

To regulate the margin, and make the lines and pages answer each other when printed on the opposite side of the sheet, two iron points are fixed to the middle of the wooden sides of the frame of the tympan, which make two holes in the sheet. These holes are placed on the same pins, when the sheet is returned for making an impression on the other side, which is called the reiteration, and the pins are adjustable, that they may make the impressions of the opposite sides exactly correspond.

The ink, when the improved inking cylinder is not employed, is applied upon the form by balls, which are a kind of wooden cups with handles, the cavities of which are filled with wool, or hair, covered with prepared sheep's skin nailed to the wood. One of these the pressman takes in each hand, and applying them on the ink-block *u*, to charge them with ink, he works them one against the other, to mix and distribute the ink equally; and, at last, inks over the form, by beating or dabbing them several times over the whole face of it; this leaves the form in a condition to be passed under the press, with the moistened paper laid on it.

The taste for elegant typography, and the increased demand for books of every description, which followed the rapid extension of arts, sciences, and literature, throughout Europe, soon rendered an improvement on the printing press a desideratum. It was found that the common press was deficient in the necessary power to produce a sharp and beautiful impression from the types. Besides this deficiency of power, which rendered the pressmen's operations very laborious, another was, that only the half of the sheet could be printed at a time. Among the first attempts to remedy these defects, was an improvement made in France. It consisted of a wooden press of the common construction, having a platen formed of iron, instead of wood, and made sufficiently large to print the whole side of a sheet of paper at once. The under surface of this plate was covered with brass. The screw, or spindle, instead of being turned by the bar, or lever, in the usual manner, was connected by rods, with a strong lever placed at the side of the press, and was worked by the application of both hands to the lever to bring it down nearly in the same way as when working the lever of a common pump. Though additional power was then procured, the exertion required from the pressmen was too great, to bring this press into general use. A patent was taken out in the year 1796, by Mr. Prosser, of London, for an improvement in the printing press, which consisted chiefly in a mode of increasing the power, by the addition of a spring between the cap and head, to resist the pressure upwards, and a similar one under the lower board or winter, to resist the pressure downwards.

Another improvement adapted to the common press, was made by Mr. Roworth, a printer in London, and was found to be successful in practice. For the screw, he substituted a plain vertical spindle, furnished with a bar, hose, &c. as in the common press; but the upper part, where the thread of the screw is usually cut, was a plain cylinder, fitted into a socket in the head of the press. Upon the upper end of the spindle, just beneath the head, a short cross arm is fixed, which acts against a circular inclined plane, fixed under the head of the press. When the bar or lever is turned, this short arm, acting on the inclined plane, causes the spindle to descend in the same manner as the screw; but with this advantage, that the inclined plane is formed so as to give a rapid descent to the spindle when the action first begins; and when the platen comes in contact with the tympan and types, and the pressure is begun, the plane has a very slight inclination, and a power which increases as the resistance increases.

Mr. Brown of London, in 1807, took out a patent for improvements in the construction of a press, &c. part of which may be applied to presses now in common use. His press was made of iron, and the pressure produced by a screw, which was put in action by a bevel wheel and pinion. The handle which put these parts in motion, was fixed on a spindle or shaft, attached to the side of the press.

The most successful improvement on the printing press was made about this time by the late Earl Stanhope, whose genius for mechanics led him to turn his attention to this important machine. The Stanhope press is formed of iron, and prints the whole side of a sheet of paper at once. The most important part of the invention consists in having obtained, by a combination of levers, the requisite degree of pressure without the excessive labour of the common press, where the lever or bar is fixed on the axis of the screw. A short lever is applied upon the top of the screw, and is connected by a link with the extremity of another lever, which is fixed upon the top of a spindle or axis placed parallel to the screw. To the lower end of this spindle, the handle or lever for working the press is attached; and the relative position of the levers is such, that when the pressman first pulls the handle towards him, the platen is moved or brought down with a considerable velocity; but when it arrives at the position where the pressure is required, the levers have changed their position in such a manner as to operate upon the platen with a very slow motion, and a power immensely great. This principle has been employed with certain modifications in almost every kind of printing-press that has been brought forward since the period of Lord Stanhope's invention. A view of this press (see the Plate, fig. 2,) will aid the reader in forming an idea of its construction.

For a professed improvement upon the Stanhope press, a patent was taken out by M. de Heine in 1810. The principle of this invention is the application of two sectors, or a sector and a cylinder, or a sector and a roller, to move against the other by a single or compound lever. The only material improvement is the substitution of a spiral or curved inclined plane, instead of the screw.

Some improvements were also made by Mr. Keir, on the construction of the Stanhope press, which have been considered as contributing much to its accurate working and durability. A cylindrical hole is bored in the centre of the press, into which a cylinder is accurately fitted, with the platen fixed on its lower end. To prevent the cylinder from turning round, it is made with a flat side, and a bar of iron, screwed across the two cheeks, bears against this side. Another improvement consists in the spindle, to which the handle is fixed, having a screw cut upon its lower end, which is fitted into a nut, so that when it is turned round, the spindle rises and falls a space equal to that passed over by the descent of the main screw in the same time. By this means, the connecting lever always draws in a horizontal direction. In the other presses, one end remains at the level, while the other descends, which occasions the joints to wear irregularly.

Mr. Brooke, about the same time, applied the compound levers of the Stanhope press to the common press with great success. As the wooden frame of the old press is not sufficient to afford the same resistance as those constructed of iron, the power of these presses is of course much inferior. This improvement, however, has been pretty generally adopted.

Medhurst's printing press is said to excel in the simplicity of its construction. Besides the merit it possesses in this particular, and which renders it cheaper than the Stanhope press, it has, perhaps, a greater advantage in point of power. The pressure is produced by a peculiarly beautiful arrangement of levers, differing considerably from any thing hitherto employed in machinery. This circumstance has led the inventor to denominate his mechanism a new power in mechanics.

This press is similar to the common one in all its parts; but the platen is made the full size of the sheet, and, instead of a screw, a plain spindle is employed. On the lower part of the spindle a circular collar or plate is fixed, into which the bar, or lever, which forms the handle of the press, is fastened. This plate affords steps or cups for two short iron rods or pins which extend up to the head, and are there supported by the points of two screws in the head, entering sockets cut out in the pins, which are made of steel. When the platen is up, these pins stand in an inclined position; but when the spindle is turned by the lever or handle, the circular plate in which the lower end of the pins rest turns round likewise, and, the upper end remaining stationary, they come into a vertical position. In this motion, the spindle and attached platen are forced to descend in the same manner as if a screw were employed.

In 1813 Mr. Ruthven took out a patent for a press, in which the necessary power is produced by a combination of levers alone.

All the alterations or improvements hitherto mentioned, retain the original principles of placing the types on a moveable carriage, where, after being inked, they are passed under the power for producing the impression, and then returned; the reverse of this is the construction of Ruthven's; and as it is from this his decided point of excellence chiefly arises, we shall be a little particular in explaining it. When the types on the moveable carriage comes under the pressure, a horizontal and perpendicular motion is in action, which effectually prevents that necessary steadiness requisite to produce a clear impression. In Ruthven's presses, the types are fixed on a stationary tablet; the upper surface is brought over by the side till it connects itself at each end with the parts under the tablet, which consists of a combination of levers and cranks, that produce an inconceivable power, and are so placed that while the power is applied at each end, the resisting point is up against the under surface of the tablet; by this arrangement, the horizonal motion with the types is completely avoided; and as the upper surface cannot come in contact with the types till in a situation exactly over them, that point is gained which has been so long desired, of the upper surface descending steadily on the types. Another important object is also here attained, the power being applied at each end of the upper surface, an equality of pressure is thereby diffused, not to be attained by any other press, where the power is applied in the centre of the upper surface. The result arising from these combined advantages is not only a clearness of impression that enables a general observer to distinguish the work printed by them, but, a saving in the durability of the types, from the manner of producing the impression.

The improvement in Mr. Russel's printing press is derived chiefly from the two-fold application of the principle which was first introduced by Lord Stanhope, and which nearly all other press-makers have found it advisable to adopt, though in varied degrees.

The Albion press by Mr. Cope is a contrivance of considerable merit. Its power is very great, its aggregate weight is much less than many others, and the ease with which it may be worked adds much to its importance and value; but our limits prevent us from detailing its particular excellencies. Many other presses besides those we have mentioned have been presented to the public, of which we cannot enter into even an enumeration. There is, however, one, the Columbian press, which from its amazing power, merits a particular, though brief description.

For this press we are indebted to the ingenuity and talent of Mr. George Clymer, of Philadelphia, in North America, who, after manufactured a supply of them for our transatlantic brethren, arrived in this country, in 1817, to introduce his press to the printers of Europe, which had given such universal satisfaction to those connected with the art in that portion of the globe. The highly favourable and very flattering testimonials which Mr. Clymer produced on his arrival in London, from the gentlemen connected with the press in different parts of the United States, where they had been in active operation, clearly evinced to the printers of Great Britain and Europe, that his invention was well deserving their countenance and encouragement; and, notwithstanding they had presses not only of the Stanhopean manufacture, but also of several others, yet the properties of Mr. Clymer's Columbian press, supported by the above testimonials, was the immediate cause of their introduction into several of the first houses in the metropolis, and many of the others soon followed; they were also introduced into several of the first printing-offices on the continent; and we sincerely hope that Mr. Clymer has been handsomely remunerated from them for his ingenuity and ability. Of this extraordinary press, fig. 3, in the Plate, gives a faithful representation; the parts of which we shall briefly describe, to enable pressmen to fix them up or take them down, when they require either cleaning or removing.

This press is composed of the following parts: the feet, staple, ribs, fore-stay, rounce, main lever, elbow-piece, counterpoise lever, links, table, platen, piston, cheek or guide pieces, back bar, back-return lever, shoulder piece, bar, connecting rod, eagle, &c.

Having brought the staple on or near to the spot on which you intend to fix the press, then put the feet (as marked) into their respective places, and raise the staple upon them. The ribs should now be screwed to the staple, and also the leg, or fore-stay, by which the near end of them is supported, but the stay is not fastened to the floor; at the top of this stay is a projecting piece of iron, with a bolster upon it, which prevents the carriage from running back.

The rounce is attached to the ribs by means of caps and bolts, which are fastened to the projections from the ribs.

The main lever must next be raised into its station: it is connected to the staple by a strong steel bolt, which fits according to a small mark, and is pinned on the other side, to prevent its working out.

The elbow piece is made in the form of two sides of a triangle: it has one square, and three round holes through it; that at the angle is the one which connects it to the projecting part of the long side of the staple, in which is a mortise to receive it; this done, two holes will remain below, and the square one above; the centre round hole receives the bolt, on each end of which is the lower part of the links; the lower hole is for the bolt which attaches the knob piece to the long end of the elbow piece: on the upper end of the last mentioned is the square hole for connecting the back-return lever.

The counterpoise lever (whereon stands the eagle, which causes the return of the platen and bar) works on two pivots on the top of the long side of the staple, and rests upon a small piece of wood in the mouth of the dolphin, on the upper part of the main lever. The counterpoise and main levers are connected by means of a short brass rod, with a hook at one end, and a screw at the other; the former fits into the mouth of the dolphin at the end of the counterpoise lever, and the latter passes through a hole at the end of the main lever, which is drawn up by a nut on the under side, and by which nut the main lever, and consequently the platen, are raised or lowered at pleasure, by screwing or unscrewing this nut.

The links fit on each side of the main lever and the elbow piece, to which they are attached by means of two steel bolts, which are pinned on the opposite side, to prevent their working out; by these links the main lever is drawn down when the impression is taken.

The table is an iron surface turned off in a lathe to the greatest exactness, with long cramps underneath, which run in the ribs, and which act as bearers to the table when the impression is taken; the girths from the barrel of the rounce are fastened to projections attached to the table in the usual manner; corner irons are screwed on as well as the tympan joints, as before described.

The platen is also turned off in a lathe, so as to meet the even surface of the table: in the centre is a high square, on which the piston is fixed, with four holes to receive the ends of the side-headed screws which secure the piston to the platen; ridges project from this square to the ends, corners, and sides of the latter, by which it is prevented from springing when the pull is made; the platen should now be placed on the table with two pieces of wood, about letter height, underneath; the four side-headed screws are next put into their respective holes in the platen (as marked,) and the small wedges placed behind to keep them in their stations: a square piece of iron, or pieces of sheet iron or tin, are laid in the centre of the platen to increase or reduce the power. The piston is now lifted on the small piece of iron in the centre of the platen, and the screws passed through the four holes in the former, and the nuts screwed on, which bind the piston and platen together; care should be taken that the marked sides of the platen and piston are both kept in the front. The table, with the piston and platen, is now run to the centre of the staple, which will bring the upper part of the piston directly under the trunnion of the main lever, which is connected to the piston by means of the caps and bolts attached to the latter. The platen must be regulated by the screws which secure the piston, when a form is laid on.

The cheek, or guide pieces, which the angles of the piston slide through, and which keep the piston and platen steady, fit on two projections from the insides of the staple, and are fastened by four bolts with nuts and screws. The left-hand one is tightened by means of a small key, or wedge, which passes between the projection from the staple and the cheek pieces; on the right hand one is a piece of iron with a screw through it, which the elbow of the bar strikes against when the latter is brought down: this screw is for the purpose of partially regulating the power.

The back bar slides into two bevels on the back of the staple, behind the main lever, which is for the purpose of preventing the staple from springing, when the power is applied by means of the bar.

The back-return lever fits into the square hole in the upper angle of the elbow piece; it has a small sliding weight, which acts a counterpoise to the eagle on the top lever.

The bar, or shoulder piece, fits into two projections from the off-side of the staple, to which one end is attached by a steel bolt, and in the other is a square hole made to receive the end of the bar, which is pinned on the inside: the middle of the shoulder piece is cast hollow, to admit one end of the connecting rod, which is attached by a small bolt.

The connecting rod is made of wrought iron: one end has an eye, which fits between the hollow in the middle of the shoulder piece, through both of which pass a small pin; the other end is tapped, to screw on the swivel attached to the knob piece, and by which, from the bar, the whole machine is put into motion. It should be recollected, that one side of the eye is filed away to admit the rod to vary a small degree from a right angle, otherwise it would not meet the swivel attached to the knob piece. To increase the power, take out the small bolt in the middle of the shoulder piece, and turn the rod to the right; that is, take up the screw: to diminish it, turn the rod to the left, *viz.* lengthen the rod by unscrewing: the filed part of the eye must always be kept downwards.

*Composition Inking Balls.*—Having noticed the principal improvements that have been made in printing presses, those which have taken place in the means of supplying the type with ink must not be omitted. Until of late, the common pelt balls, consisting of sheep skin stuffed with wool, and nailed to the ball stock, were in constant use, and in many places their services are still retained. About the year 1816 composition balls first made their appearance at Weymouth, being made by Mr. B. Foster, a compositor, of that place. At first their introduction was much opposed by many masters and pressmen in London, but they have gradually gained ground and got into general use. These balls are made of molassses, glue, and a portion of tar, which are boiled together to a proper consistency. It is then poured on a piece of cloth, and when sufficiently cold is nailed to the ball-stock like the common sheep skin. Should these balls be hard, when dirty, they may be washed with a little weak lie, and rinsed with water; if soft, a little ink may be laid on them and scraped: but every pressman must use his own judgment, as variations will arise from boiling and the state of the weather.

When the Times newspaper was first printed by machinery, the power being cylindrical, rollers were indispensably necessary. These were formed of the above composition, and being found to answer the expected purpose, in 1819 hand rollers were introduced to the notice of the pressmen. These came very rapidly into use, and are likely to continue. They are coated with the above composition, and made in the form represented in fig 4. They have been found admirably adapted for heavy forms, but not so well for light ones, and are subject to the changes of the weather. The inking frames or tables by which the rollers are supplied with ink, are constructed as represented in fig. 5. The whole is composed of iron, with the cylinder turned off to the greatest exactness, under which is a steel edge that scrapes the ink off the cylinder, to the exact quantity required. This is regulated by means of counterpoise levers that pass under the table, on which are hung two weights, to be removed according to the quantity required for the work in hand. One end of each lever passes against the *ductor* or *regulator*. The ductor and cylinder are fixed so closely together that the cavity will hold water, and consequently no ink can escape more than is actually wanted. The cylinder has an ornamental cover, which is always kept on, except when a fresh supply of ink is required. By this means all dust and dirt is kept from the ink and the cylinder. The latter is moved by a small handle at the end. The table is turned off in a lathe perfectly true, the same as in the presses.

*Printing Machines.*—Among the numerous inventions of the present age, those of machines for printing are not the least remarkable. Prior to their introduction, the press department was one of great labour, whenever extraordinary expedition was required. This was particularly the case with newspapers, of which, with the utmost exertion, scarcely ever more than 750 copies could be produced in an hour. The consequence was, that in newspaper offices, where the circulation was extensive, it was found necessary, in order to get the paper published in time, to compose two or more copies, so that by going to press at the same time, the demands of the public might be complied with; thus occasioning an enormous increase of expenditure both in the compositors' and press departments. In a newspaper circulating seven or eight thousand copies, this expense, annually, could not have been less than £2000; all of which has been saved by the introduction of machines, which are worked by steam or hand.

The first machine used in London was made, we believe, by two Saxons, named König and Baur, in 1814. This machine, or one upon a similar principle, is now in use, worked by steam, at the Times' office, and there are others in various other offices. The great expense of erecting machines worked by steam, led to the invention of others, which are worked by hand, but which have been liable to many objections on the score of the labour requisite in turning the wheel, and the injury to the type. It appears, that Mr. Miller, of Fleet-street, after an expenditure of several thousand pounds, and the most unwearied exertions, has succeeded in producing a machine capable of working 2000 sheets per hour, without any danger of accident, and with comparatively little labour to the persons employed; whilst, from the simplicity of the construction, and the regularity of the action, the type has not even the ordinary wear of the common printing press.

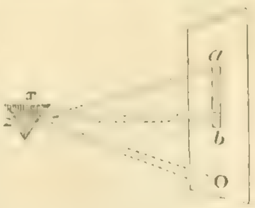
The machine, which appears in fig. 6 in the engraving, will communicate to the reader some idea of the manner in which the operation is performed:—A boy is represented as laying on A, the sheet of white paper, B is the cylinder which prints the first side of the paper, C intermediate cylinders over which the paper travels to D, the cylinder which gives the final impression. At E are the inking rollers, under which the form (that is, the types) is in the act of passing; F is the reservoir of ink, from which the inking rollers are supplied; G is the form receiving the last inking under the printing cylinder. At H, is seen a sheet just delivered into the hands of another boy, whose business it is to keep the sheets, as they come out, in a heap. The lines at the top of the machine represents the tapes which run round the cylinders and secure the sheet. In this curious process the form of types is placed on a carriage, which slides backwards and forwards along rails upon the fixed frame of the machine, so as to pass beneath the surface of the large printing cylinder. The blank sheet of paper being laid on the tympan, is carried down between rollers and tapes under the cylinder, which presses it upon the form of types, and prints it. It is thence conducted forwards, and delivered on other tapes to the boy who is stationed to receive it. The tapes which carry the sheet of paper along the surface of the cylinder, are narrow enough to lie in the spaces between the pages for printing; they, therefore, do not prevent the sheet from applying itself to the types, although they pass entirely across its surface, so as to keep it in place. These tapes are arranged over small pulleys, which can be fixed at any required distance apart, so as to accord with the spaces between the pages for printing different kinds of work, such as folios, quartos, octavos, &c. The mode of procuring register is by points, which can be moved with every facility in any direction.

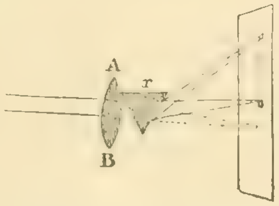
The machine has two distinct sets of inking apparatus, one at each end, being so arranged as to furnish and distribute the ink, by means of elastic composition rollers, upon the form of types, as it moves backwards and forwards underneath them. The reservoirs of ink from which the rollers are supplied, are fixed on each end of the carriage, near which are also other rollers to distribute the ink uniformly over the surface of the inking rollers. The rollers being made to pass twice over the types before an impression is made from them, produce an effect in inking them, equivalent to what would be afforded by passing the common inking roller four times over them, which is all that is usually deemed necessary to distribute the ink equally over the types, so as to render the impression clear and uniform. The feeding roller is supplied with ink by means of a trough and regulating scraper. While the impression is being produced, the receiving roller is brought in contact with the feeding roller while in motion, and receives a sufficient quantity of ink for the next impression, while the type carriage is returning to its first position. The distributing roller, whilst revolving, has, at the same time, a lateral motion given to it, in order to distribute the ink over the whole surface of the composition rollers. The power of the pressing cylinder, and of the inking roller, can be regulated and adjusted with mathematical accuracy, so that a strong or a light impression, as the nature of the work may require, can be given with the utmost nicety.

Several of these printing machines are now in constant use in the metropolis, varying from each other in some subordinate particulars, but all founded on one common principle. Since the first introduction of machines, they have been considerably simplified, particularly in the complexity of their inking apparatus. For this we are indebted to the genius of Messrs. Applegath and Cowper, who have produced a machine far superior to that by Mr. Koënig, and which possesses nothing in common with it, but the pressing cylinders, the inking rollers, and the tapes to hold the sheet of paper on the cylinders. The pressing cylinders and inking rollers were first suggested by Mr. Nicholson; and tapes are similarly used in machines for the ruling of paper for account books. These gentlemen, therefore, though producing their machine subsequently to Mr. Koënig, cannot, with justice, be accused of having, in the slightest degree, infringed upon his invention. Mr. Koënig's machine possessed originally *sixty* wheels; Messrs. Applegath and Cowper's but *sixteen*; and the machines of the former are now almost entirely superseded, even in the office of Mr Bensley, the principal proprietor of Koënig's patent, by the improved machines of Applegath and Cowper.

**PRISM**, in Geometry, is a body, or solid, whose two ends are any plain figures which are parallel, equal, and similar; and its sides connecting those ends are parallelograms. Hence, every section parallel to the base, is equal and similar to the base; and the prism may be considered as generated by the parallel motion of this plane figure. Prisms receive particular names, according to the figure of their bases; as a *triangular* prism, a *square* prism, a *pentagonal* prism, a *hexagonal* prism, and so on. And hence the denomination prism comprises also the cube and parallelopipedon, the former being a square prism, and the latter a rectangular one. And even a cylinder may be considered as a round prism, or one that has an infinite number of sides. Also a prism is said to be regular or irregular, according as the figure of its end is a regular or an irregular polygon. The axis of a prism, is the line conceived to be drawn lengthways through the middle of it, connecting the centre of one end with that of the other end. Prisms, again, are either right or oblique. A right prism is that whose sides and its axis are perpendicular to its ends, like an upright tower. And an oblique prism, is when the axis and sides are oblique to the ends; so that, when set upon one end, it inclines on one hand more than on the other The principal properties of prisms are, 1. That all prisms are to one another in the ratio compounded of their bases and heights. 2 Similar prisms are to one another in the triplicate ratio of their like sides. 3. A prism is triple of a pyramid of equal base and height; and the solid content of a prism is found by multiplying the base by the perpendicular height. 4. The upright surface of a right prism is equal to a rectangle of the same height, and its breadth equal to the perimeter of the base or end. And therefore such upright surface of a right prism, is found by multiplying the perimeter of the base by the perpendicular height. Also the upright surface of an oblique prism is found by computing those of all its parallelogram sides separately, and adding them together. And if to the upright surface be added the areas of the two ends, the sum will be the whole surface of the prism.

**Prism**, in Optics, is an instrument employed for shewing the properties of solar light, and consists merely of a triangular prism of glass, which separates the rays of light in their passage through it, in consequence of the different degrees of refrangibility that has place in the component part of the same ray. It is, for instance, by means of this instrument that the origin of colours is shewn to be owing to the composition which takes place in the rays of light, each heterogeneous ray consisting of innumerable rays of different colours. Thus, a ray being let into a darkened room, through a small round aperture *z*, and falling on a triangular glass prism *x*, is by the refraction of the prism considerably dilated, and will exhibit on the opposite wall an oblong image *a b*, called a spectrum, variously coloured, the extremities of which are bounded by semicircles, and the sides rectilinear. The colours are commonly divided into seven, which, however, have various shades, gradually intermixed at their juncture. Their order, beginning from the side of the refracting angle of the prism, is red, orange, yellow, green, blue, purple, and violet. The obvious conclusion from this experiment is, that the several component parts of solar light have different degrees of refrangibility, and that each subsequent ray in the order above mentioned, is more refrangible than the preceding. As a circular image would be depicted by the solar ray unrefracted by the prism, so each ray that suffers no dilation by the prism would mark out a circular image O. Hence, it appears that the spectrum is composed of innumerable circles of different colours. The mixture, therefore, is proportionable to the number of circles mixed together; but all such circles lie between those of two contingent circles, consequently the mixture is proportionable to the interval of those centres; *viz.* to the breadth of the spectrum. Consequently, if the breadth can be diminished, retaining the length of the rectilinear sides, the mixture will be lessened proportionably; and this is done by the following process:—At a considerable distance from the hole *z*, place a double convex lens A B, whose focal length is equal to half that distance, and place the prism *x* behind the lens; then at a distance behind the lens, equal to the distance from the hole, will be formed a spectrum, the length of whose rectilinear sides is the same as before, but its breadth much less; for the undiminished breadth was equal to a line subtending, at the distance of the spectrum from the hole, an angle equal to the apparent diameter of the sun, together with a line equal to the diameter of the hole; but the reduced breadth is equal to the diameter of the hole only: the image of the hole formed by the lens, at the distance of double its focal length, is equal to the hole; therefore its several images, in the different kinds of rays, are equal to the same; *viz.* the breadth of the reduced spectrum is equal to the diameter of the hole. It is also known from experiment, that a prism placed in an horizontal position will project the ray into an oblong form, but if another horizontal prism be applied, similar to the former, to receive the refracted light emerging from the first, and having its refracting angle turned the contrary way from that of the former, the light, after passing through both prisms, will assume a circular form, as if it had not been at all refracted. But if the light, after emerging from the first prism be received on another prism, perpendicular to the former, it will be refracted by this into a position inclined to the former, but its breadth will remain the same. In order now to shew that the different colours suffer no manner of change from any number of refractions, let there be placed close to the prism a perforated board, and let the refracted light transmitted through the hole be received on another board parallel to the former, and likewise perforated with a small hole; and behind this hole place another prism with its refracting angle downwards, and turn the first prism slowly about its axis, and the light will then move up and down the second board; let the different colours be turned successively, and mark the place of the different coloured rays on the wall after their refraction at the second prism; it will then be found that the red is seen the lowest, and the violet the highest, and the rest in the intermediate space in their order. From these experiments, aided by some others which our limits will not admit of detailing, the following conclusions have been drawn, *viz.* The solar rays may be resolved into different coloured rays; these coloured rays are immutable, either by reflection or refraction. That from the mixture of these coloured rays in due proportion solar light may be produced; and consequently that the differently coloured rays exist in solar light, though, when blended together in their natural proportions, it exhibits no traces of colour. *See* Colour.





**PRISMOID**, a figure resembling a prism.

**PRISON**, a gaol, or place of confinement.

**PRISTIS**, or saw-fish, a genus of fishes of the order chondropterigii: there are five species.

**PRIVATEER**, a vessel of war, armed and equipped by particular merchants, and furnished with a military commission from the state, to cruise against and annoy the enemy, by taking, sinking, or burning their shipping.

**PRIVILEGE**, in Law, some peculiar benefit granted to certain persons or places, contrary to the usual course of the law

**PRIVY**, in Law, denotes one who is partaker, or has an interest in an affair.

**Privy Council**, is the principal council belonging to the king, and is generally called by way of eminence the council. Privy counsellors are made by the king's nomination, without either patent or grant; and on taking the necessary oaths, they become immediately privy counsellors, during the life of the king that chooses them, but subject to removal at his discretion: no convenience now arises from the extension of the privy council, as those only attend who are especially summoned for that particular occasion.

**Privy Seal**, is a seal that the king uses to such grants, or other things as pass the great seal.

**PRIZE**, a vessel taken from the enemy. Vessels are looked on as prizes, if they fight under any other standard than that of the state from which they have their commission, if they have no charter-party, invoice, or bill of lading, aboard; if loaded with effects belonging to the king's enemies, or even contraband goods. Those of the king's subjects recovered from the enemy, after remaining four-and-twenty-hours in their hands, are deemed lawful prize. Vessels that refuse to strike may be constrained; and if they make resistance and fight, become lawful prize if taken. By stat. 13 Geo. II. ch. 4, judges and officers failing of their duty in respect to the condemnation of prizes, forfeit £500 with full costs of suit, one moiety to the king, and the other to the informer.—The regulations with regard to prizes in the royal navy are as follow: 1. When any ship or vessel is taken from the enemy, the hatches are to be immediately spiked up, and her lading and furniture secured from embezzlement, till sentence is passed upon her in some court of admiralty empowered to take cognizance of causes of that nature. 2. The captain is to cause the officers of the prize to be examined: three or more of the company, who can give best evidence, to be brought to the said court of admiralty, together with the charter-parties, bills of lading, and other ships' papers found on board. Articles 3 and 4 relate to the finding any of the king's subjects in the prizes. 5. When a privateer is taken, great care is to be had to secure all the ships' papers, especially the commission: but if there be no legal commission found on board, then all the prisoners are to be carried before some magistrate, in order to their being examined and committed as pirates.

**Prize** *Money*, the profits arising from the sale of such prize. In ships of war, the prize money is to be divided among the officers, seamen, &c. as his majesty shall appoint by proclamation; but among privateers, the division is according to the agreement between the owners.

**PRIZING**, the application of a lever to move any weighty body, as an anchor, &c.

**PROBABILITY of an Event**, in the doctrine of Chances, is the ratio of the number of chances by which the event may happen, to the number by which it may both happen and fail. So that, if there be constituted a fraction, of which the numerator is the number of chances for the events happening, and the denominator the number for both happening and failing, that fraction will properly express the value of the probability of the event's happening.

PROBABILITY *of Life*. *See* EXPECTATION.

**PROBABILITIES**, the same as CHANCES.

**PROBATE** of WILLS, is the exhibiting and proving wills or testaments before the ecclesiastical judges.

**PROBE**, a surgeon's instrument for examining the circumstances of wounds, &c.

**PROBLEM**, in Logic, a proposition that neither appears absolutely true nor false, and consequently may be asserted either in the affirmative or negative.

PROBLEM, in Geometry, is a proposition wherein some operation or construction is required; as, to divide a line or angle erect, or let fall perpendiculars.

PROBLEM, in Algebra, is a question or proposition which requires some unknown truth to be investigated, and the truth of the discovery demonstrated.

**PROBOSCIS**, in Natural History, is the trunk or snout of an elephant, and some other beasts and insects.

**PROCEDENDO**, is a writ which lies where a cause is removed out of an inferfor to a superior court.

**PROCELLARIA**, the petrel, in Natural History, a genus of birds of the order anseres. There are twenty-three species, of which the following are the principal:—The giant petrel, more than three feet long, and about seven wide. These birds are often seen sailing just above the water without moving their wings for a long time together, and being particularly alert on the approach of storms, often fill the mariners with apprehension and alarm. They abound most in southern latitudes, and though their principal food is fish, devour also the putrid carcases of seals and whales.—The pintado petrel, abounds about the coasts of the Cape of Good Hope. These birds are about the size of the kittiwake, and are often observed in such numbers that many hundreds have been taken in one night.—The fulmar petrel weighs nearly a pound and a half, and is found in the northern coasts of this island, and thence even beyond Iceland and Greenland, where the natives use it for food, though its flesh is highly offensive to those not used to it. The fat is burnt in their lamps. These birds subsist chiefly on fish, but often banquet on the carcases of whales, particularly the fat parts, which they afterwards eject from their stomachs into the mouths of their young. They often spurt it in the faces of their enemies, and exhibit indeed no other mode of resistance. They are stated to be so amazingly fat, that, on being passed through the hands with great compression, the fat flows off like oil.—The shear-water petrel is smaller than the last. These birds are found in vast numbers in the Orkneys, where they are highly valued for their feathers as well as flesh.—The stormy petrel is of the size of a swallow, and rarely seen but at sea; and in tempestuous weather numbers are observed following, as if for shelter, in the wakes of vessels. They dive sometimes for half an hour together, and live principally upon fish, but will eat a variety of offal thrown from ships.—In the Ferro Islands they are so astonishingly fat, that the natives are stated to use them as candles, after drawing a wick through their bodies.

**PROCESS**, in Law, is the manner of proceeding in every cause, being the writs and precepts that proceed, or go forth, upon the original upon every action, being either civil or criminal.

**PROCLAMATION**, a public notice given of any thing of which the king thinks proper to advertise his subjects.

**PROCTOR**, a person commissioned to manage another person's cause, in any court of the civil or ecclesiastical law.

**PROCURATOR**, a person who has a charge committed to him to act for another.

**PROCYON**, a fixed star of the second magnitude in the constellation CANIS *Minor*.

**PROD**, is a vessel used in the South Seas. This name, which signifies flying, it has obtained on account of the swiftness with which it sails, being, with a brisk trade wind, near twenty miles an hour. It is chiefly used by pirates.

**PRODUCING**, in Geometry, signifies the drawing out a line farther till it has any assigned length.

**PRODUCT**, in Arithmetic and Algebra, is the quantity arising from the multiplication of two or more factors together.

**PROFILE**, denotes the outline of a figure, building, member of architecture, &c.

PROFILE, in Sculpture and Painting, denotes a head, portrait, &c. when represented sideways, or in a side view.

**PROGRESSION**, an orderly advancing or proceeding in the same manner, course, tenor, proportion, &c.

**PROGRESSION**, in Arithmetic and Algebra, a series of numbers advancing or proceeding in the same manner, or according to a certain law, &c.—Progression is either arithmetical, or geometrical.

*Arithmetical* PROGRESSION, is a series of three or more quantities that have all the same common difference; as 3, 5, 7, &c. which have the common difference 2; and $a$, $a + d$, $a + 2d$, &c. which have all the same difference $d$.

**PROHIBITION**, is a writ properly issuing only out of the Court of King's Bench, being the king's prerogative writ; but, for the furtherance of justice, it may now also be had in some cases out of the Court of Chancery, Common Pleas, or Exchequer, directed to the judge and parties of a suit in an inferior court, commanding them to cease from the prosecution thereof, upon a suggestion, that either the cases originally, or some collateral matter arising therein, does not belong to that jurisdiction, but the cognizance of some other court. Upon the court being satisfied, that the matter alleged by the suggestion is sufficient, the writ of prohibition immediately issues.

**PROJECTILES**, are such bodies as, being put in a violent motion by any great force, are then cast off or let go from the place where they received their quantity of motion; as a stone thrown from a sling, an arrow from a bow, a bullet from a gun, &c. *See* GUNNERY.

**PROJECTION**, in Mechanics, the art of giving a body its projectile motion. *See* PROJECTILES.

PROJECTION, in Perspective, denotes the appearance or representation of an object on the perspective plane. *See* PERSPECTIVE.

PROJECTION of the *Sphere in Plano*, is a representation of the several points or places of the surface of the sphere, and of the circles described upon it, upon a transparent plane placed between the eye and the sphere, or such as they appear to the eye placed at a given distance. The principal use of the projection of the sphere is in the construction of planispheres, maps, and charts, which are said to be of this or that projection, according to the several situations of the eye, and the perspective plane, with regard to the meridians, parallels, and other points or places so represented. The most usual projection of maps of the world, is that on the plane of the meridian, which exhibits a right sphere, the first meridian being the horizon. The next is that on the plane of the equator, which has the pole in the centre, and the meridians the radii of a circle, &c. The projection of the sphere is usually divided into orthographic and stereographic; to which may be added gnomonical.

*Orthographic* PROJECTION, is that in which the surface of the sphere is drawn upon a plane cutting it in the middle; the eye being placed at an infinite distance vertically to one of the hemispheres.

*Stereographic* PROJECTION of the *Sphere*, is that in which the surface and circles of the sphere are drawn upon the plane of a great circle, the eye being in the pole of that circle.

*Gnomonical* PROJECTION of the *Sphere*, is that in which the surface of the sphere is drawn upon an external plane commonly touching it, the eye being at the centre of the sphere.

**PROLATE**, in Geometry, a term applied to a spheroid produced by the revolution of a semi-ellipsis about its transverse diameter; and is thus distinguished from an oblate sphere, which is produced by the revolution of the ellipse about its conjugate diameter.

**PROMISE**, is where, upon a valuable consideration, persons bind themselves by words to do or perform such a thing agreed on: it is in the nature of a verbal covenant, and wants only the solemnity of writing and sealing to make it absolutely the same. Yet for the breach of it, the remedy is different; for instead of an action of covenant, there lies only an action upon the case, the damages whereof are to be estimated and determined by the jury.

**PROMONTORY**, a high cape, or head-land.

**PRONOUN**, in Grammar, a declinable part of speech, which being put instead of a noun, points out some person or thing.

**PRONUNCIATION**, in Grammar, the manner of articulating the words of a language.

**PROOF**, the shewing or making plain the truth of any matter alleged; either in giving evidence to a jury on a trial, or else on interrogatories, or by copies of records, or exemplications of them.

**PROPORTION**, is often confounded with ratio; but they are quite different things. For, ratio is properly the relation of two magnitudes or quantities of one and the same kind; as the ratio of 4 to 8, or 15 to 30, or of 1 to 2, and so implies or respects only two terms or things. But proportion respects four terms or things, or two ratios which have each two terms; though the middle term may be common to both ratios, and then the proportion is expressed by three terms only, as 4, 8, 64, where 4 is to 8 as 8 to 64.

**Proportion**, in Mathematics, is an equality or similitude of ratio; thus, if the ratio $a$ to $b$ is the same as that of $c$ to $d$; that is, if $\frac{a}{b} = \frac{c}{d}$, then $a, b, c, d$, are in proportion, which is denoted by placing the quantities thus; $a : b :: c : d$, or $a : b = c : d$, and is read as a *is to* b, *so is* c *to* d.

**Proportion**, though sometimes confounded with ratio, differs from it in this, that ratio has only a relation to two quantities of the same kind, whereas proportion relates to the comparison of two such ratios.—Proportion differs also from progression in this, that in the former it is only required that there should be an equality between the ratio of the 1st and 2nd term, and that of the 3d and 4th; whereas to constitute a progression there must be the same ratio between each two adjacent terms: these two cases, however, are sometimes distinguished by the terms *discrete* and *continued* proportion.

**Proportion**, is also *direct* and *inverse*, or *reciprocal*, *alternate*, &c. Thus if the ratio of $a$ to $b$ is equal to the ratio $c$ to $d$, then,

| | |
|---|---|
| direct ........................ | $a : b :: c : d$ |
| inversion .................... | $b : a :: d : c$ |
| alternate .................... | $a : c :: b : d$ |
| composition...... | $a + b : b :: c + d : d$ |
| conversion ....... | $a + b : a :: c + d : c$ |
| division ........ | $a - b : a :: c - d : c$<br>$a - b : b :: c - d : d$ |

**Proportion**, is again distinguished into arithmetical, geometrical, and harmonical.

*Arithmetical* **Proportion**, is the equality of two arithmetical ratios or differences. As in the numbers 12, 9, 6; where the difference between 12 and 9, is the same as the difference between 9 and 6, *viz.* 3. And here the sum of the extreme terms is equal to the sum of the means, or to double the single mean when there is but one. As $12 + 6 = 9 + 9 = 18$.

*Geometrical* **Proportion**, is the equality between two geometrical ratios, or between the quotients of the terms. *See* the preceding article.

*Harmonical* **Proportion**, is when the first term is to the third, as the difference between the 1st and 2d is to the difference between the 2d and 3d; or in four terms when the 1st is to the 4th, as the difference between the 1st and 2d is to the difference between the 3d and 4th; or the reciprocals of an arithmetical proportion are in harmonical proportion. As 6, 4, 3; because $6 : 3 :: 6 - 4 = 2 : 4 - 3 = 1$; or because $\frac{1}{6}$, $\frac{1}{4}$, $\frac{1}{3}$, are in arithmetical proportion, making $\frac{1}{6} + \frac{1}{3} = \frac{1}{4} + \frac{1}{4} = \frac{1}{2}$. Also the four 24, 16, 12, 9, are in harmonical proportion, because $24 : 9 :: 8 : 3$.

*Compass* of **Proportion**, a name by which the French, and some English authors, call the sector.

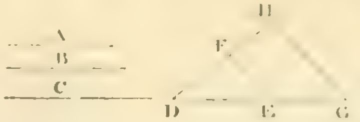
**PROPORTIONAL**, relating to proportion, as proportional *compasses*, *parts*, *scales*, *spiral*, &c. for which see the respective terms.

**Proportional**, also denotes one of the terms of a proportion, which receives particular denominations according to the place it holds in the proportion, as a *mean* proportional, a *third*, *fourth*, &c. proportional.

*Mean* **Proportional**, is the middle term of three continued geometrical proportionals. *See* **Mean** *Proportional.*

*Fourth* **Proportional**, is the fourth term of a geometrical proportion, which is found arithmetically by dividing the product of the second and third terms by the first.

*To find a fourth Proportional to three given Lines*, A, B, C.—

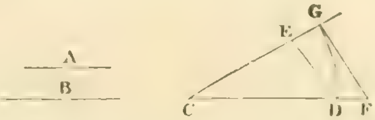


From any point D draw two lines, making any angle G D H. In these lines take D F equal to the first term A, D E equal to the second B, and D H equal to the third C. Join F E, and draw H G parallel to it, and D G will be the fourth proportional required. That is,

D F (A) : D E (B) : : D H (C) : D G.

*Third* **Proportional**, is the third of three terms in continued proportion, and is found arithmetically by dividing the square of the second term by the first.

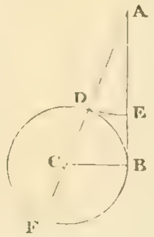
*To find a third Proportional to two given Lines*, A *and* B.—



From any point C draw two right lines, making an angle F C G. In these lines take C E equal to the first term A, and C G, C D, each equal to the second term B. Join E D, and draw G F parallel to it; and C F will be the third proportional required. That is,

C E (A) : E G (B) : : C D (B) : C F.

*To cut a Line in extreme and mean Proportion;* that is, so that the whole line may be to the greater part, as the greater part is to the less.



Let A B be the given line, and draw B C perpendicular to it and equal to half of it. From the centre C with radius C B describe the circle D B F; join A C, and with A D as radius and A as a centre, describe the arc D E cutting A B in E, so shall the line A B be divided in extreme and mean proportion in the point E.

**PROPOSITION**, in Logic, part of an argument wherein some quality, either negative or positive, is attributed to a subject.

**PROPOSITION**, in Mathematics, is either some truth advanced, which is to be demonstrated, or some operation proposed, which is to be performed and shown to be that which was required. Being, in the former case, called a theorem, and in the latter a problem.

**PROSODY**, that part of Grammar which treats of the quantities and accents of syllables, and the manner of making verses.

**PROSOPOPŒIA**, a figure in Rhetoric, whereby we raise qualities, or things inanimate, into persons.

**PROSTHAPHERESIS**, is the same as the **Equation** of the *Centre.*

**PROSTYLE**, in ancient Architecture, a range of columns in front of a temple.

**PROTEST**, when one openly affirms, that he does either not at all, or but conditionally, yield his consent to any act, or unto the proceeding of a judge in court wherein his jurisdiction is doubtful, or to answer upon his oath any farther than by law he is bound.

**Protest**, is also that act by which the holder of a bill of exchange declares, that such bill is dishonoured.

**Protest**, in naval language, an instrument drawn up in writing, and attested before a justice of the peace (or a consul or vice-consul in foreign parts,) by the master of a merchant-ship and a part of the ship's crew, after the expiration of a voyage, describing the severity of the voyage, whereby the ship has suffered, or may suffer, in her hull, rigging, or cargo. It is chiefly intended to shew that such damages did not happen through any neglect or misconduct of the master or his officers, &c.

**PROTESTANT**, a name first given in Germany to those who adhered to the doctrine of Luther; because in 1529 they protested against a decree of the emperor Charles V. and the diet of Spires; declaring, that they appealed to a general council.

The same name also has been given to those of the sentiments of Calvin, and is now become a common denomination for all those of the reformed churches.

PROTHONOTARY, a term which properly signifies first notary, and which was anciently the title of the principal notaries of the emperors of Constantinople. Prothonotary with us is used for an officer in the Courts of King's Bench and Common Pleas; the former of which courts has one, and the latter three. The prothonotary of the King's Bench records all civil actions sued in that court, as the clerk of the crown-office does all criminal causes. The prothonotaries of the Common Pleas enter and enrol all declarations, pleadings, assizes, judgments, and actions; they also make out all judicial writs, except writs of habeas-corpus, and distringas jurator, for which there is a particular office, called the *habeas corpora* office; they likewise enter recognizances acknowledged, and all common recoveries; make exemplification of records, &c.

PROTOXIDE, in Chemistry, a term used to denote the minimum of oxidizement.

PROTRACTION, the same with plotting.

PROTRACTOR, is the name of an instrument used for protracting or laying down on paper the angles of a field or other figure. The protractor is a small semicircle of brass, or other solid matter, the limb or circumference of which is nicely divided into one hundred and eighty degrees; it serves not only to draw angles on paper, or any plane, but also to examine the extent of those already laid down. For this last purpose let the small point in the centre of the protractor be placed above the angular point, and make the side coincide with one of the sides that contain the angle proposed; then the number of degrees cut off by the other side, computing on the protractor, will shew the quantity of the angle that was to be measured. Protractors are now more usually made in the form of a parallelogram, and properly graduated at the upper edge.

PROVIDENCE, the conduct and direction of the several parts of the universe, by a superior intelligent Being.

PROVINCE, the circuit of an archbishop's jurisdiction.

PROVISO, in Law, a condition inserted in a deed, upon the observance whereof the validity of the deed depends.

PROVOST, an officer, whereof there are divers kinds, civil, military, &c.

Provost of a city or town, is the chief municipal magistrate in several trading cities, particularly in Scotland, being the same with mayor in England.

Provost *Marshal of an Army*, is an officer appointed to seize and secure deserters, and all other criminals. He is to hinder soldiers from pillaging, to indict offenders, and to see the sentence passed on them executed. He also regulates the weights and measures, and the price of provisions, &c. in the army.

PROVOST-MARSHAL, an officer appointed to take charge of prisoners at a court-martial.

PROW, a name given by seamen to the beak or pointed cut-water of a xebec, galley, or polacre. The upper part of the prow is usually furnished with a grating platform for the convenience of the seamen, who walk out to perform whatever is necessary about the sails or rigging on the bowsprit.

PRUNELLA Vulgaris. (*Selfheal.*) The leaves have an herbaceous roughish taste, and hence stand recommended in hæmorrhages and alvine fluxes. It has been principally celebrated as a vulnerary, whence its name; and in gargarisms for aphthæ and inflammations of the fauces.

PRUNELLÆ, Sal, a preparation of purified saltpetre.

PRUNES, are plums dried in the sunshine, or in an oven.

PRUNING, in Gardening and Agriculture, is the lopping off the superfluous branches of trees, in order to make them bear better fruit, grow higher, or appear more regular. Pruning, though an operation of very general use, is nevertheless rightly understood by few; nor can it be learned by rote, or, indeed, wholly by books, but requires a strict observation of the different manners of growth of the several sorts of fruit trees; the proper method of doing which cannot be known, without carefully observing how each kind is naturally disposed to produce its fruit; for some do this on the same year's wood as vines; others, for the most part, upon the former year's wood, as peaches, nectarines, &c. and others, upon spurs which are produced upon wood of three, four, &c. to fifteen or twenty years' old, as pears, plums, cherries, &c. therefore, in order to the right management of fruit trees, provision should always be made, to have a sufficient quantity of bearing wood in every part of the trees, and at the same time there should not be a superfluity of useless branches, which would exhaust the strength of the trees, and cause them to decay in a few years. The reasons for pruning of fruit trees are, 1. To preserve them longer in a vigorous bearing state: 2. To render them more beautiful: and, 3. To cause the fruit to be larger and better tasted.

PRUNUS, a genus of the monogynia order, in the icosandria class of plants; and in the natural method ranking under the 36th order pomaceæ. There are thirty-three species.

Prunus Domestica. (*The Common Plum Tree.*) The medical effects of the damson and common prunes are, to abate heat, and gently loosen the belly; which they perform by lubricating the passage, and softening the excrement. They are of considerable service in costiveness accompanied with heat or irritation, which the more stimulating cathartics would tend to aggravate: where prunes are not of themselves sufficient, their effects may be promoted by joining with them a little rhubarb or the like; to which may be added some carminative ingredient, to prevent their occasioning flatulencies. *Prunelloes* have scarce any laxative quality; these are mild, grateful refrigerants, and by being occasionally kept in the mouth, usefully allay the thirst of hydropic persons.

Prunus *Lauro-cerasus.* (*The Common Laurel.*) The leaves of the laurel have a bitter taste, with a flavour resembling that of the kernels of the peach or apricot; they communicate an agreeable flavour to aqueous and spirituous fluids, either by infusion or distillation. The distilled water applied to the organs of smelling strongly impresses the mind with the same ideas as arise from the taste of peach blossoms or apricot kernels: it is so extremely deleterious in its nature, and sometimes so sudden in its operation, as to occasion instantaneous death; but it more frequently happens that epileptic symptoms are first produced. This poison was discovered by accident in Ireland in the year 1728; before which, it was no uncommon practice there, to add a certain quantity of laurel water to brandy, or other spirituous liquors, to render them agreeable to the palate. At that time three women drank some laurel-water; and one of them a short time afterwards became violently disordered, lost her speech, and died in about an hour. A gentleman at Guildford, some few years back, also, by making an experiment as he intended on himself, was poisoned by a small dose: he did not survive the taking it more than two hours. In consequence of the above poisonous principle existing in the laurel, it has been recommended to persons to be cautious how they make use of the leaves of that shrub, which is a usual practice with cooks for giving flavour to custards, blanch-mange, and other made-dishes, lest the narcotic principle should be also conveyed, to the detriment of the health of persons who eat of them. And the same may be said of the kernels of all stone-fruits; for the flavours given to noyau, ratafia, and other liquors which are highly prized by epicures, are all of them derived from the same principle as laurel-water, and which, on chemical investigation, is found to be prussic acid. This exists in considerable quantities in the bitter almond, and which when separated proves to be the most active poison known, to the human as well as all other animal existence. This principle, and its mode of extraction, should be made equally as public as the necessity of scientific researches requires. We cannot with propriety accuse either this tree or the laurel as being poisonous, because the ingenuity of mankind has found out a mode of extracting this active acidulous principle, and which is so very small in proportion to the wholesome properties of the fruit, as not to be suspected of any danger but for this discovery. As well might we accuse wheat of being poisonous, because it yields on distillation *brandy*, which has been known to kill many a strong-bodied fellow who has indulged in this favourite beverage to excess. An eminent chemist observes, that he has made experiments with the oxalic acid, and found that when this was also concentrated, it has similar effects; insomuch that no animal can contain a grain of it if taken into the throat or stomach: and thus might we also be led to consider the elegant, and in itself harmless, wood-sorrel, as a poisonous plant.

PRUSSIC Acid, in Chemistry and the Arts, is one of the most important of the acids. It was discovered by accident about the beginning of the last century by Diesbach, a chemist of Berlin. This gentleman wishing to precipitate a decoction of cochineal with an alkali, got some potash, on which he had distilled for several times his animal oil, and as there was some sulphate of iron in the decoction, the liquor instantly exhibited a beautiful blue in the place of a red precipitate. Hence he saw the method of producing the same substance at pleasure, and it soon became an object of commerce, and obtained the name of Prussian blue, from the place where it was discovered. This substance is now formed chiefly during the decomposition of animal substances in high temperatures. Three parts of blood, evaporated to dryness in an iron dish, are to be mixed with one part of subcarbonate of potash (common pearlash), and calcined in a crucible, which should be only two-thirds filled by the materials, and covered with a lid. The calcination must be continued with a moderate heat as long as the flame issues from the crucible; and when it becomes faint, and likely to be extinguished, the process must be stopped. Throw the mass when cold, into ten or twelve parts of water; allow it to soak a few hours, and then boil them together in an iron kettle. Filter the liquor, and continue pouring hot water on the mass as long as it acquires any taste. To this solution add one composed of two parts of alum and one of sulphate of iron in eight or ten of boiling water, and continue the mixture as long as any effervescence and precipitation ensues. Wash the precipitate several times with boiling water. It will have a green colour; but on the addition of a quantity of muriatic acid, equal to twice that of the sulphate of iron which has been used, it will assume a beautiful blue colour. Wash it again with water, and dry it in a gentle heat. In this state it is the pigment, called Prussian blue, which consists of a mixture of prussiate of iron with alumine. From prussiate of iron, the prussic acid may be separated by the following process: mix two ounces of red oxide of mercury, prepared by nitric acid, with four ounce of finely powdered Prussian blue, and boil the mixture with twelve ounces of water in a glass vessel, shaking frequently. Filter the solution, which is a prussiate of mercury, while hot, and when cool add to it in a bottle two ounces of iron filings, and six or seven drachms of sulphuric acid; shake these together, decant the clear liquor into a rectort, and distill off one-fourth of the liquor. The distilled liquor is the prussic acid, which combines with alkalies and earths, and has many of the properties belonging to the other acids. It has a sweetish taste, and a smell resembling that of bitter almonds: it does not redden blue vegetable colours. It precipitates sulphurets, and curdles soap. It separates allumine from nitric acid. Oxygenized muriatic acid entirely decomposes it. It does not appear to have a strong affinity for alkalies, nor does it take them from carbonic acid, for no effervescence arises on adding it to a solution of alkaline carbonates; on the contrary, its combinations with alkalies and earths are decomposed by exposure to carbonic acid, even when highly diluted, as in atmospheric air. It readily combines, however, with pure alkalies, destroys their alkaline properties, and forms crystallizable salts. It does not precipitate iron blue, but green, and this green precipitate is soluble in acids. The rays of light render the green precipitate blue, as does also the addition of metallic iron, or sulphurous acid.

PRUSSIAN BLUE. *See* Prussic Acid.

PRYTANEUM, in Grecian Antiquity, a large building in Athens, where the council of the prytanes or presidents of the senate assembled, and where those who had rendered any signal service were maintained at the public expense.

PSALTERIUM GEORGII, the *Harp of George*, is a new constellation, introduced by one of the German astronomers, in honour of his late Britannic Magesty George III. It is bounded on the north by Taurus, on the east by Sceptrum Brandenburgium, on the south by Eridanus, and on the west by Cetus.

PSITTACUS, or Parrot, a genus belonging to the order of picæ. The bill in this genus is hooked from the base: and the upper mandible is moveable; the nostrils are round, placed in the base of the bill, which in some species is furnished with a kind of cere; the tongue is broad, and blunt at one end; the head is large, and the crown flat; the legs are short, the toes placed two before and two behind. These abound within the tropics, and live on seeds and fruit, in their natural state, but in confinement will eat both flesh and fish. They often appear in flocks, yet are in such cases generally somewhat separated into pairs. They are noisy, mimetic, singularly capable of articulating human sounds, extremely docile, and long lived. They breed in the hollows of trees, without constructing any nest, and use their feet as hands to convey food to their mouths. Latham notices one hundred and thirty three species, and Gmelin no fewer than one hundred and sixty-nine. The general division is regulated by the evenness or unevenness of the tails

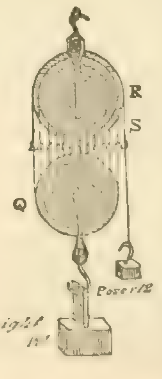
PTOLEMAIC, or *Ptolemean System of Astronomy*, is that invented by Claudius Ptolemæus, a celebrated astronomer and mathematician of Pelusium in Egypt, who lived in the beginning of the second century of the Christian æra. This hypothesis supposes the earth immoveably fixed in the centre, of the universe; and that the sun, the moon, the planets, and stars, all move about it from east to west, once in twenty-four hours, in the order following, *viz*. the Moon next to the Earth, then Mercury, Venus, the Sun, Mars, Jupiter, Saturn, the fixed stars, the first and second crystalline heavens, and, above all, the fiction of their primum mobile.

PUDDING, a sea term, or Puddening, a thick wreath or circle of cordage, tapering from the middle towards the ends, pointed all over, and fastened about the main or fore masts of a ship, directly below the trusses, to prevent the yards from falling down, when the ropes by which they are usually suspended are shot away in battle. *Puddening* is also sometimes placed on a boat's stem as a kind of fender.

PUDDING Stone, in Chemistry, a term invented by English lapidaries to designate one particular mineral aggregate, consisting of oblong and rounded pebbles of flint, about the size of almonds, imbedded in a hard siliceous cement. The pebbles are usually black, and the cement of a light yellowish brown. It is capable of receiving a very high polish, and is used in ornamental works. It is found chiefly in Essex. The French mineralogists have naturalized the term *poudingue*, and have applied it to all rounded stones imbedded in a cement, so as to make it nearly synonymous to the English "rubble-stone."

PULEX, the *Flea*, a genus of insects of the order aptera.

PULLEY, one of the simple machines, or, as they are commonly called, *mechanical powers*; its theory is laid down under Mechanics. The present article is introduced for the purpose of mentioning some ingenious practical combinations of pulleys, in addition to those already exhibited. The usual methods of arranging pulleys in their blocks may be reduced to two. The first consists in placing them one by the side of another upon the same pin: the other, in placing them directly under one another upon separate pins. Each of these methods, however, is liable to inconvenience; and Mr. Smeaton, to avoid the impediments to which these combinations are subject, proposes to combine these two methods in one. A very considerable improvement in the construction of pulleys has been made by James White, who obtained a patent for his invention, of which he gives the following description.—The annexed figure shews the machine, consisting of two pulleys, Q and R, one fixed and the other moveable. Each of these has six concentric grooves capable of having a line put round them, and thus acting like as many different pulleys, having diameters equal to those of the grooves. Supposing then each of the grooves to be a distinct pulley, and that all their diameters were equal, it is evident that if the weight 144 were to be raised by pulling at S till the pulleys touch each other, the first pulley must receive the length of line as many times as there are parts of the line hanging between it and the lower pulley. In the present case there are twelve lines *b*, *d*, *f*, &c. hanging between the two pulleys, formed by its revolution about the six upper and



lower grooves. Hence, as much line must pass over the uppermost pulley as is equal to twelve times the distance of the two. But, from an inspection of the figure, it is plain that the second pulley cannot receive the full quantity of line by as much as is equal to the distance betwixt it and the first. In like manner, the third pulley receives less than the first by as much as is the distance between the first and third; and so on to the last, which receives only one-twelfth of the whole: for this receives its share of line *n* from a fixed point in the upper frame, which gives it nothing; while all the others in the same frame receive the line partly by turning to meet it, and partly by the line coming to meet them. Supposing now these pulleys to be equal in size, and to move freely as the line determines them, it appears evident, from the nature of the system, that the number of their revolutions, and consequently their velocities, must be in proportion to the number of suspending parts that are between the fixed point above mentioned, and each pulley respectively. Thus the outermost pulley would go twelve times round in the time that the pulley under which the part *n* of the line, if equal to it, would revolve only once; and the intermediate times and velocities would be a series of arithmetical proportionals, of which, if the first number were 1, the last would always be equal to the whole number of terms. Since then the revolutions of equal and distinct pulleys are measured by their velocities, and that it is possible to find any proportion of velocity on a single body running on a centre, *viz.* by finding proportionate distances from that centre; it follows, that if the diameters of certain grooves in the same substance be exactly adapted to the above series, (the line itself being supposed inelastic, and of no magnitude,) the necessity of using several pulleys in each frame will be obviated, and with that some of the inconveniences to which the use of the pulley is liable. In the figure referred to, the coils of rope by which the weight is supported are represented by the lines *a*, *b*, *c*, &c.: *a* is the line of traction, commonly called the fall, which passes over and under the proper grooves, until it is fastened to the upper frame just above *n*. In practice, however, the grooves are not arithmetical proportionals, nor can they be so; for the diameter of the rope employed must in all cases be deducted from each term; without which the smaller grooves, to which the said diameter bears a larger proportion than to the larger ones, will tend to rise and fall faster than they, and thus introduce worse defects than those which they were intended to obviate. The principal advantage of this kind of pulley is, that it destroys lateral friction, and that kind of shaking motion which is so inconvenient in the common pulley. These pulleys, when well executed, apply to jacks and other machines of that nature with peculiar advantage, both as to the time of going and their own durability; and it is possible to produce a system of pulleys of this kind of six or eight parts only, and adapted to the pocket, which, by means of a skain of sewing silk, or a clue of common thread, will raise upwards of a hundred weight. The friction of the pulley is now reduced to almost nothing by Mr. Garnett's ingenious patent friction-rollers, which produce a great saving of labour and expense, as well as in the wear of the machine, both when applied to pulleys and to the axles of wheel-carriages. His general principle is this; between the axle and nave, or centre pin and box, a hollow space is left, to be filled up by solid equal rollers nearly touching each other. These are furnished with axles inserted into a circular ring at each end, by which their relative distances are preserved; and they are kept parallel by means of wires fastened to the rings between the rollers, and which are riveted to them.

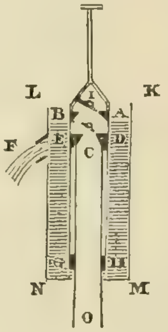
**PULO**, is a general term for island on the coasts of Siam and the island of Sumatra, in the East Indies, and in the Eastern Indian Ocean.

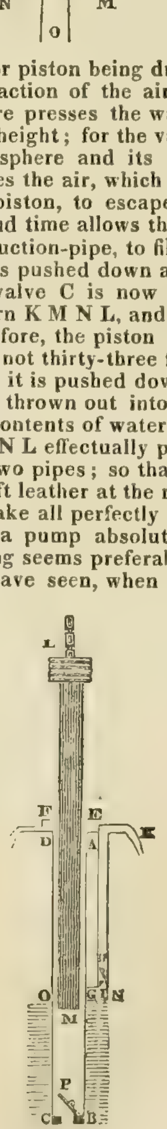
**PULSE**, in the animal economy, denotes the beating or throbbing of the heart and arteries.

**PUMICE** STONE, or porous glasses. When the compact glasses are exposed to the heat of our furnaces, they emit a great number of air bubbles, which render them porous; such is the origin of pumice. It has the same base as compact glass. The texture is fibrous: the fibres have a silky lustre. Colours various; white, brown, yellow, black. Before the blow-pipe, they melt into a white enamel.

**PUMP**, a hydraulic machine for raising water by the pressure of the atmosphere. The most important and certain part of the theory of pumps has been laid down in the construction of two or three kinds which have been already described in this work, under the articles CENTRIFUGAL MACHINE, FIRE-ENGINE, FORCER, and HYDRAULICS. A few other useful, yet not complex, pumps, will be described in the present article; and some account will be added of the most ingenious pistons and valves.

A modification of the sucking-pump which has been much recommended, is exhibited in the annexed figure. Here the suction-pipe C O comes up through a cistern K M N L deeper or longer than the intended stroke of the piston, and has a valve C at top. The piston, or what acts in lieu of it, is a tube A H G B, open at both ends, and of a diameter somewhat larger than that of the suction-pipe. The interval between them is filled up at H G by a ring or belt of soft leather, which is fastened to the outer tube, and moves up and down with it, sliding along the smoothly polished surface of the suction-pipe with very little friction. There is a valve I on the top of this piston, opening upwards. Water is poured into the outer cistern. The outer cylinder or piston being drawn up from the bottom, there is a great rarefaction of the air which was between them, and the atmosphere presses the water up through the suction-pipe to a certain height; for the valve I keeps shut by the pressure of the atmosphere and its own weight. Pushing down the piston causes the air, which had expanded from the suction-pipe into the piston, to escape through the valve I: drawing it up a second time allows the atmosphere to press more water into the suction-pipe, to fill it, and also part of the piston. When this is pushed down again, the water which had come through the valve C is now forced out through the valve I into the cistern K M N L, and now the whole is full of water. When, therefore, the piston is drawn up, the water follows, and fills it, if not thirty-three feet above the water in the cistern; and when it is pushed down again, the water which filled the piston is all thrown out into the cistern; and after this it delivers its full contents of water every stroke. The water in the cistern K M N L effectually prevents the entrance of any air between the two pipes; so that a very moderate compression of the belt of soft leather at the mouth of the piston cylinder is sufficient to make all perfectly tight.



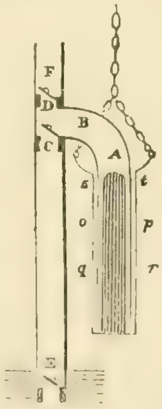


If a pump absolutely without friction be wanted, the following seems preferable for simplicity and performance to any we have seen, when made use of in proper situations. Let N O, in the figure, be the surface of the water in the pit, and K the place of delivery. The pit must be as deep in water as from K to N O. A B C D is a wooden trunk, round or square, open at both ends, and having a valve P at the bottom. The top of this trunk must be on a level with K, and has a small cistern E A D F. It also communicates laterally with a rising pipe G H K, furnished with a valve at H opening upwards. L M is a beam of timber so fitted to the trunk as to fill it without sticking, and is of at least equal length. It hangs by a chain from a working beam, and is loaded on the top with weights exceeding that of the column of water which it displaces. Now suppose this beam allowed to descend from the position in which it is drawn in the figure; the water must rise all round it, in the crevice which is between it and the trunk, and also in the rising pipe; because the valve P shuts, and H opens; so that when the plunger has got to the bottom, the water will stand at the level of K. When the plunger is again drawn up to the top by the action of the moving power, the water sinks again in the trunk, but not in the rising pipe, because it is stopped by the valve H. Then allowing the plunger to descend again, the water must again rise in the trunk to the level of K, and it must now flow out at K; and the quantity discharged will be equal to the part of the beam below the surface of the pit-water, deducting the quantity which fills the small space between the beam and the trunk. This quantity may be reduced almost to nothing, for if the inside of the trunk and the outside of the beam be made tapering, the beam may be let down till they exactly fit; and as this may be done in square work, a good workman can make it exceedingly accurate. But in this case, the lower half of the beam and trunk must not taper; and this part of the trunk must be of sufficient width round the beam to allow free passage into the rising pipe. Or, which is better, the rising pipe must branch off from the bottom of the trunk. A discharge may be made from the cistern E A D F, so that as little water as possible may descend along the trunk when the piston is raised.

There can be no doubt, that the above is a very ingenious contrivance, and that it fully answers every purpose to which it can be rendered applicable. Indeed, it may be asserted with safety, that among the numerous ramifications into which mechanism and the mechanic arts have been extended, scarcely any branch furnishes a greater variety than may be found in pump machinery. Under this article many combinations of power are presented to the reader; but several others, equally deserving of attention, are left unnoticed, lest the whole should become too extended. We have endeavoured to select from the field of diversity such specimens, as display in the powers of invention the greatest portion of originality. Among these, pumps that are constructed to accomplish the desired end, either without friction, or with its aggregate greatly diminished, imperiously claim an admission into the pages of our scientific miscellany.

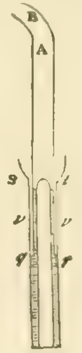
The most ingenious contrivance of a pump without friction is that of Haskins, described in Phil. Trans. No. 370, and called by him the *Quicksilver Pump*. Its construction and mode of operation are complicated; but the following preliminary observations will, we hope render them abundantly plain.

Let there be (see fig.) a cylindrical iron pipe, about six feet long, open at top; also another cylinder, connected with it at bottom, and of smaller diameter. It may either be solid, or, if hollow, it must be close at top. Let a third iron cylinder, of an intermediate diameter, be made to move up and down between the other two without touching either, but with as little interval as possible. This middle cylinder communicates by means of the pipe A B, with the upright pipe F E, having valves C and D (both opening upwards) adjoining to the pipe of communication. Suppose the outer cylinder suspended by chains from the end of a working beam, and let mercury be poured into the interval between the three cylinders till it fills the space to about three-fourths of their height. Also suppose that the lower end of the pipe F E is immersed into a cistern of water, and that the valve D is less than 33 feet above the surface of this water.



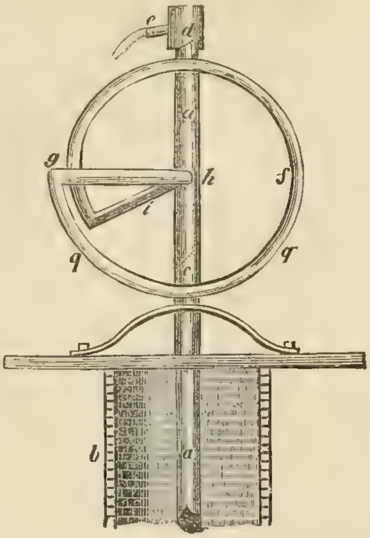
Now, suppose a perforation made somewhere in the pipe A B, and a communication made with an air-pump. When the air-pump is worked, the air contained in C E, in A B, and in the space between the inner and middle cylinders, is rarified, and is abstracted by the air-pump; for the valve D immediately shuts. The pressure of the atmosphere will cause the water to rise in the pipe C E, and will cause the mercury to rise between the inner and middle cylinders, and sink between the outer and middle cylinders. Let us suppose mercury 12 times heavier than water; then for every foot that the water rises in E C, the level between the outside and inside mercury will vary an inch: and if we suppose D E to be 30 feet then if we can rarefy the air so as to raise the water to D the outside mercury will be depressed to *q* and *r*, and the inside mercury will have risen to *s*, *t*, *s q*, and *t r*, being about 30 inches. In this state of things, the water will run over by the pipe B A, and every thing will remain nearly in this position. The columns of water and mercury balance each other, and balance the pressure of the atmosphere. While things are in this state of equilibrium, if we allow the cylinders to descend a little, the water will rise in the pipe F E, which we may now consider as a suction pipe; for by his motion the capacity of the whole is enlarged, and therefore the pressure of the atmosphere will still keep it full, and the situation of the mercury will again be be in equilibrio. It will be a little lower in the inside space, and higher in the outside.

Taking this view of things, we see clearly how the water is supported by the atmosphere at a very considerable height. The apparatus is analogous to a syphon which has one leg filled with water and the other with mercury. But it was not necessary to employ an air-pump to fill it. Suppose it again empty, and all the valves shut by their own weight. Let the cylinders descend a little. The capacity of the spaces below the valve D is enlarged, and therefore the included air is rarefied, and some of the air in the pipe C E must diffuse itself into the space quitted by the inner cylinder. Therefore the atmosphere will press some water up the pipe F E, and some mercury into the inner space between the cylinders. When the cylinders are raised again, the air which came from the pipe C E would return into it again, but is prevented by the valve C. Raising the cylinders to their former height would compress this air; it therefore lifts the valve D, and escapes. Another depression of the cylinders will have a similar effect. The water will rise higher in F C, and the mercury in the inner space; and then after repeated strokes the water will pass the valve C, and fill the whole apparatus, as the air-pump had caused it to do before.



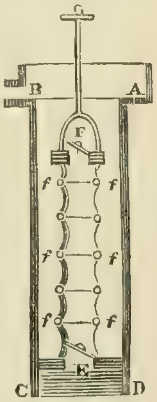
The position of the cylinders when things are in this situation is represented in this figure, the outer and inner cylinder in their lowest position having descended about 30 inches. The mercury in the outer space stands at *q r*, a little above the middle of the cylinders, and the mercury in the inner space is near the top *t s* of the inner cylinder. Now let the cylinders be drawn up. The water above the mercury cannot get back again through the valve C, which shuts by its own weight. We therefore attempt to compress it; but the mercury yields, and descends in the inner space, and rises in the outer till both are quickly on a level, about the height *v v*. If we continue to raise the cylinders, the compression forces out more mercury, and it now stands lower in the inner than in the outer space. But that there may be something to balance this inequality of the mercurial columns, the water goes through the valve D, and the equilibrium is restored when the height of the water in the pipe E D above the surface of the internal mercury is twelve times the difference of the mercurial columns (on the former supposition of specific gravity). If the quantity of water be such as to rise two feet in the pipe E D, the mercury in the outer space will be two inches higher than that in the inner space. Another depression of the cylinders will again enlarge the space within the apparatus, the mercury will take the position of the last figure, and more water will come in. Raising the cylinders will send this water four feet up the pipe E D, and the mercury will be four inches higher in the inner than in the outer space. Repeating this operation, the water will be raised still higher in D E; and this will go on till the mercury in the outer space reaches the top of the cylinder: and this is the limit of the performance. The dimensions with which we set out will enable the machine to raise the water about 30 feet in the pipe E D; which, added to the 30 feet of C F, makes the whole height above the pit water 60 feet. By making the cylinders longer we increase the height of F D. This machine must be worked with great attention, and but slowly; for at the beginning of the forcing stroke the mercury very rapidly sinks in the inner space and rises in the outer, and will dash out and be lost. To prevent this as much as possible, the outer cylinder terminates in a sort of cup or dish, and the inner cylinder should be tapered at the top.

A Quicksilver Pump has been lately contrived by a Mr. Clarke of Edinburgh, for the purpose of raising water without friction, and in its construction is essentially different from that of Mr. Haskins, having great power in drawing and forcing water to any height, and possessing extreme simplicity in its construction.



*a a* is the main pipe inserted into the well *b*; a valve is situated at *c*, and another at *d*, both opening upwards; a piece of iron tube is then bent into a circular form, as at *f*, again turned off at *g* in an angular direction, so as to pass through a stuffing box at *h*, and from thence bent outwards as at *i*, connecting itself with the ring. A quantity of quicksilver is then put into the ring filling it from *q* to *q*, and the ring being made to vibrate upon its axis *h*, a vacuum is effected in the main pipe by the recession of the mercury from *g* to *i*, thereby causing the water to rise and fill the vacuum; upon the motion being reversed, the quicksilver slides back to *g*, forces up the water, and expels it at the spout *e*. Mr. Clark calculates that a pump of this description with a ring twelve feet in diameter, will raise water the same height as the common lifting pump, and force it one hundred and fifty feet higher without any friction.

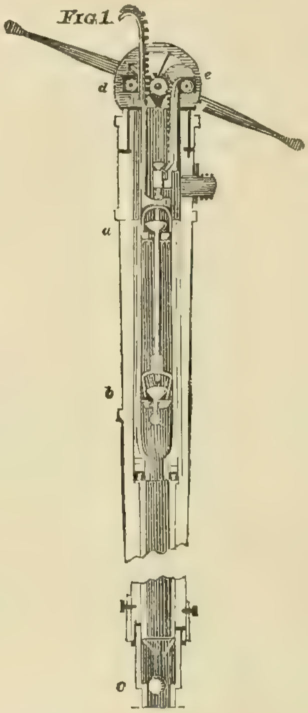
The following pump, without friction, may be constructed in a variety of ways by any common carpenter, without the assistance of the pump-maker, or plumber, and will be very effective for raising a great quantity of water to small heights, as in draining marshes, marl pits, quarries, &c. or even for the service of a house.



A B C D in this figure is a square trunk of carpenter's work open at both ends, and having a little cistern and spout at top. Near the bottom there is a partition made of board, perforated with a hole E, and covered with a clack, *f f f f* represent a long cylindrical bag made of leather or of double canvass, with a fold of thin leather, such as sheepskin, between the canvass bags. This is firmly nailed to the board E with soft leather between. The upper end of this bag is fixed on a round board having a hole and valve F. This board may be turned in the lathe with a groove round its edge, and the bag fastened to it by a cord bound tight round it. The fork of the piston rod F G is firmly fixed into this board; the bag is kept distended by a number of wooden hoops or rings of strong wire *ff*, *ff*, *ff*, &c. put into it at a few inches' distance from each other. It will be proper to connect these hoops before putting them in, by three or four cords from top to bottom, which will keep them at their proper distances. Thus will the bag have the form of a barber's bellows powder-puff. The distance between the hoops should be about twice the breadth of the rim of the wooden ring to which the upper valve and piston rod are fixed. Now let this trunk be immersed in the water. It is evident that if the bag be stretched from the compressed form which its own weight will give it by drawing up the piston rod, its capacity will be enlarged, the valve F will be shut by its own weight, the air in the bag will be rarefied, and the atmosphere will press the water into the bag. When the rod is thrust down again, this water will come out by the valve F, and fill part of the trunk. A repetition of the operation will have a similar effect; the trunk will be filled, and the water will at last be discharged by the spout.—The same bag-piston may be employed for a forcing pump, by placing it below the partition, and inverting the valve; and it will then be equally strong, because the resistance in this case too will act by compression.

*Single Barrel Pump, with a Double Action.*—An ingenious variation in the construction of the sucking pump, is that with two piston rods in the same barrel, invented by the late W. Taylor, of Southampton. A vertical section of this pump is given in the figure.

Fig. 1.

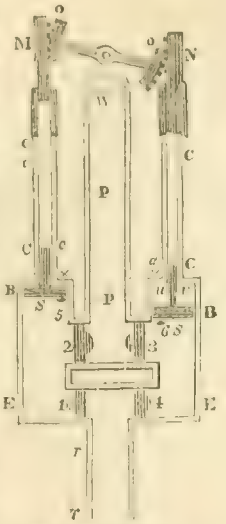


The piston rods have racks at their upper parts working on the opposite sides of a pinion, and kept to their proper positions by friction rollers. The valves used in this pump are of three kinds, as shewn at *a*, *b*, and *c*. The former is a spheric segment which slides up and down on the piston rod, and is brought down by its own weight: the second, *b*, is called the pendulum valve; and the third, *c*, is a globe which is raised by the rising water, and falls again by its own weight. Each of these valves will disengage itself from chips, sand, gravel, &c. brought up by the water. In this kind of pump the pistons may either be put in motion by a handle in the usual way, or a rope may pass round the wheel *d e* in a proper groove, the two ends of which, after crossing at the lower part of the wheel, may be pulled by one man or more, on each side. A pump of this kind, with a seven-inch bore, heaves a ton twenty-four feet high in a minute, with ten men, five only working at a time on each side.

Another improvement of the common pump has been made by Todd, of Hull. This invention, in some particulars, bears a resemblance to the ordinary one, but he has contrived to double its powers by the following means:—Having prepared the piston cylinder, which may be twelve feet high, he cuts from the bottom thereof about three feet; at the end of the great cylinder he places an atmospheric valve, and to the top of the small cylinder a serving valve. In the bottom of the small cylinder, which contains the serving valve, is inserted an oblong elliptical curved tube, of equal calibre with the principal cylinder, and the other end is again inserted in the top of the great cylinder. This tube is divided in the same manner as the first cylinder, with atmospheric and serving valves, exactly parallel to the valves of the first cylinder. The pump, thus having double valves, produces double effects, which effects may be still further increased by extending the dimensions. This pump, in addition to its increased powers, possesses another very great and prominent advantage. By screwing to it the long leather tube and fire-pipe of the common engine, it is in a few minutes converted into an effective fire-engine. Hence, whoever possesses one, may be said to have a convenient domestic apparatus against fire. Three men can work it; one to turn the winch, another to direct the fire-pipe, and a third to supply the water.

The late Mr. Benjamin Martin invented a curious and powerful pump with two pistons, the friction of which was exceedingly small. An admirable engraving of this pump, by Lowry, is given in vol. xx. of Tilloch's Philosophical Magazine.

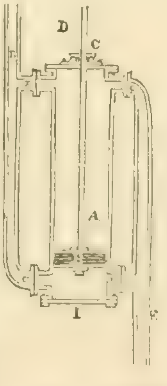
The following is a plan of a Gold Mine Pump, which will supersede the necessity of cutting new shafts, to suit the windings and various elevations and declinations of the mines. We have been informed, that in the gold and silver mines in South America, the rod pump is often rendered useless, from the want of some such contrivance



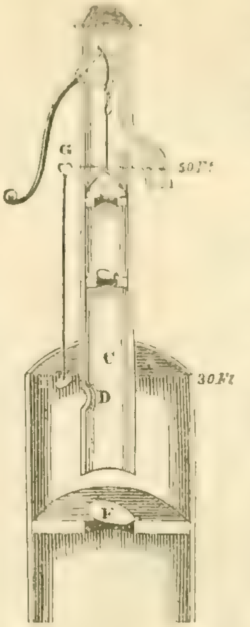
*Description.*—*r r* represent a pipe that enters the well, and is supplied with water by means of the pressing weight of the atmosphere; B E B E are two working barrels; P P, the stand pipe; C C C C are half-inch pipes filled with water; *o o* the working beam, that acts on the pistons M N, that work on the half-inch pipes; *a* S S *e* are buckets; *v v*, evacuants. If any small quantity of water issue into the evacuants, the piston blocks, x x, force it back through the valves 5, 6; the numbers 1, 2, 3, 4, represent the four valves.

Perhaps a rough calculation would be the best mode of elucidating the principle of this invention. Let us suppose the depth of the pipes C P to be 500 feet, the barrels four feet, and the pipe *r r* 16 feet; the diameter of the above to be 20 inches, except that of the pipes C C C C, which is half an inch. The weight of the water on the buckets *e a*, weighs 30 pounds; the pressure on the buckets S S is equal to 1500 pounds each; so that, at the rising of the piston M, the pressure of the atmosphere, 1500 pounds, will force the bucket S *e* up, so that the water will keep rising with the piston M, at the same time the piston N will be forcing the water downwards. The water will, in consequence, force the bucket *a*, so that the water in the barrel is forced out through the valve 3, into the pipe P P, and out at W. Now, it is easily to be perceived, that an evacuation will be created at *v*; that afterwards the piston N will be raised, and the effect will be as described of M, and the effect on M as described of N, and so on alternately, so that a continual stream will flow out at W. The pressure of 1500 pounds is produced in consequence of the buckets S S being 20 feet from the level of the water; so that there is left five pounds on the square inch, which multiplied by 300 inches, the area of the bucket, gives 1500 pounds.—The advantage of this pump is evident, as, whatever the winding of the mines might be, the pipe of such a pump might be turned accordingly, without any obstruction to the pump, and all the expense of cutting new shafts would thus be saved.

The annexed figure represents a Pump, described by M. Ozanam in his *Récréations Mathématiques et Physiques*, which appears superior to the pumps now in use. Its action and construction may be easily understood by the figure. A is the working cylinder; B, the piston, or plunger, the rod of which, D, works in an air-tight manner, through the stuffing box C. E is the suction pipe, or pipe leading from the well; and H, the discharging pipe. F F and G G are valves, all opening upwards. The piston is represented as ascending, and therefore the valves at F F are open, and at G G shut. I is the plate closing the bottom of the cylinder, and by which the whole may be securely bolted down to the work supporting it. It will easily be seen, that this pump raises water both in the ascending and descending stroke of the piston, and therefore affords a continued stream of water. Pumps with double action have been in use some time, but the one now described is more simple and powerful than those on the usual construction.



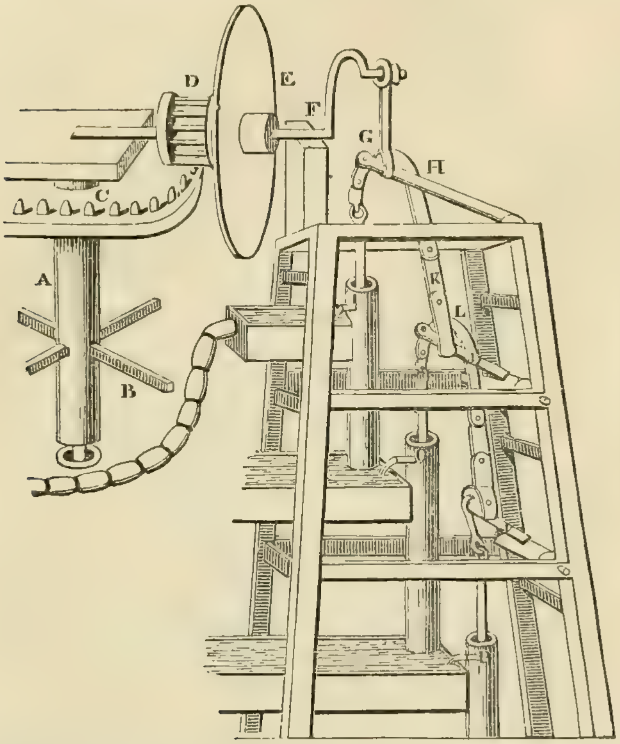
*Double Atmospheric Pump.*—This figure represents a pump for raising water from wells between 50 and 60 feet in depth, to be worked merely by a lever. Let A represent a cylinder three feet in diameter, and 30 in length, reaching below the surface of the water in the well, furnished with an aperture B at the top, C a cylinder about eight inches in diameter, with an aperture at D. Let E represent an air-tight valve, alternately to open and close the two apertures B and D. F, a valve that will open and close itself by the pressure of the atmosphere. G, the handle to be used by the operator for opening and closing the apertures B and D.



When we wish to work the pump, the aperture B must, in the first instance, be closed, and D of course will remain open, to allow the whole of the air in the large cylinder to escape, that the water may follow we then make use of the handle, and the exterior pressure of the atmosphere will raise the water to the height of 30 feet, as in the common atmospheric pump, the valve F will then be closed, and 10 feet of the water in the wide cylinder, retained 20 feet above that in the well; then by opening the aperture B, we allow the atmospheric pressure to enter, at the same time pressing the valve E against the aperture D, making it air-tight, and keeping it in that position, we are enabled, by the continued action of the piston, to raise that ten feet of water another thirty feet from its surface in the large cylinder, which will make fifty feet from its surface in the well. Again, by closing the aperture B, we repeat the operation in the same manner as before described. But if we were to have the narrow cylinder fixed at five feet down the wide one, we should then be enabled to raise the water fifty-five feet from its surface in the well. We are then enabled to raise water from wells between 50 and 60 feet in depth, not by a multiplication of pumps and cisterns, but by employing the atmospheric pressure double, or at two parts of the same pump. Instead of having the wide cylinder A to reach below the surface of the water in the well, it will be only requisite to have it as far down as the part where the valve F is situated. And it will be better to employ a small suction pipe from beneath the valve F, to the water in the well, which will produce the same effect more perfectly, and in a much shorter space of time.

The *Triple* PUMP, a sketch of which is given in the following engraving, is taken from Bockler's *Theatrum Machinarum.* The nature of the machinery by which this pump is worked, will be sufficiently obvious to any person after an inspection of the figure. The horizontal wheel C, and its shaft A, are turned by the capstan bars B; this wheel drives the pinion D, on the axle of which is the equalizing fly E, and the crank F: the rotatory motion of the crank alternately raises and depresses the bar G, with the lever H turning on a roller and pivots, and thus works the pump I: at the same time the connecting rods K move in like manner the lever M, and work the pump O; and the rods K move the lever N, and work the pump P. If the levers H, M, N, are not so contrived that the extremities of each shall move through equal spaces, the bores of I, O, and P, must be made in the inverse ratio of those spaces, otherwise one or other of the reservoirs may be drawn dry; a defect that should be carefully guarded against.

Our attention may now be directed to some of the different forms which may be given to the pistons and valves of a pump. The great desideratum in a piston is, that while it be as tight as possible, it should have as little friction as is consistent with this indispensable quality. The common form, when carefully executed, possesses these properties in an eminent degree. This piston is a sort of truncated cone, generally made of wood not apt to split, such as elm or beech. The small end of it is cut off at the sides, so as to form a sort of arch, by which it is fastened to the iron rod or spear. The two ends of the conical part may be hooped with brass. This cone has its larger end surrounded with a ring or band of strong leather fastened with nails, or by a copper hoop, which is driven on it at the smaller end; the further this end reaches beyond the base of the cone, the better; and the whole must be of uniform thickness all round, so as to suffer equal compression between the cone and working barrel. The seam or joint of the two ends of this band must be made very close; but not sewed or stitched together, as that would occasion bumps or inequalities, which would spoil its tightness; and no harm can result from the want of it, because the two edges will be squeezed close together by the compression in the barrel. Nor is it by any means necessary that this compression be great: this is a very detrimental error of the pump-makers. It occasions enormous friction, and destroys the very purpose which they have in view, *viz.* rendering the piston air-tight; for it causes the leather to wear through very soon at the edge of the cone, and it also wears the working barrel.



Belidor, an author of the first reputation, has given the description of a piston which he highly extols, and is undoubtedly a very good one, constructed from principle, and extremely well composed. It consists of a hollow cylinder of metal (fig. 1.) pierced with a number of holes, EE, FF, having at top a flanch, whose diameter is nearly equal to that of the working barrel of the pump Q N. This flanch has a groove round it. There is another flanch below, by which this hollow cylinder is fastened with bolts to the lower end of the piston, represented in fig. 2. This consists of a plate with a grooved edge similar to A B, and an intermediate plate which forms the seat of the valve. The composition of this part is better understood by inspecting the figure than by any description. The piston-rod H is fixed to the upper plate by bolts through its different branches at G O. This metal body is then covered with a cylindrical bag of leather, fastened on it by cords bound round it, filling up the grooves in the upper and lower plates. The operation of the piston is as follows:—A little water is poured into the pump, which gets past the sides of the piston, and lodges below in the fixed valve. The piston being pushed down, dips into this water, and it gets into it by the valve. But as the piston in descending compresses the air below it, this compressed air also gets into the inside of the piston, swells out the bag which surrounds it, and compresses it to the sides of the working-barrel. When the piston is drawn up again, it must remain tight, because the valve will shut and keep in the air in its most compressed state; therefore the piston must perform well during the suction. It must act equally well when pushed down again, and act as a forcer; for, however great the resistance may be, it will affect the air within the piston to the same degree, and keep the leather close applied to the barrel.

*Fig.* 1.

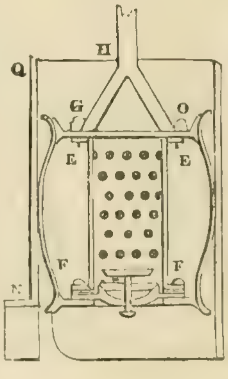
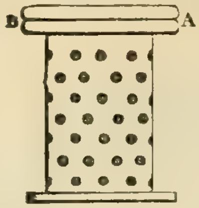
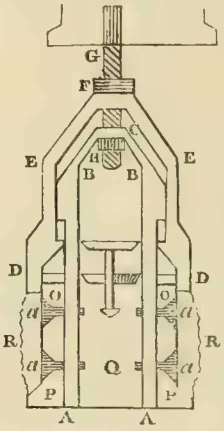


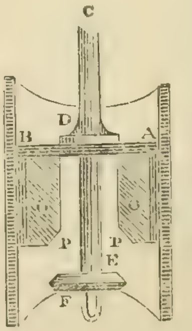
*Fig.* 2.



The following piston is also ingenious, and has a good deal of merit. O P P O, in the figure, is the box of the piston, having a perforation Q, covered above with a flat valve K, which rests in a metal plate that forms the top of the box. A B C B A is a stirrup of iron to which the box is fixed by screws *a*, *a*, *a*, *a*, whose heads are sunk in the wood. This stirrup is perforated at C, to receive the end of the piston-rod, and a nut H is screwed on below to keep it fast. D E F E D is another stirrup, whose lower part at D D forms a hoop like the sole of a stirrup, which embraces a small part of the top of the wooden box. The lower end of the piston-rod is screwed; and before it is put into the holes of the two stirrups (through which holes it slides freely) a broad nut G is screwed on it. It is then put into the holes, and the nut H firmly screwed up. The packing R R is then wound about the piston as tight as possible till it completely fills the working-barrel of the pump. When long use has rendered it in any degree loose, it may be tightened again by screwing down the nut G. This causes the ring D D to compress the packing between it and the projecting shoulder of the box at P P; and thus causes it to swell out, and apply itself closely to the barrel. Prony, in his Architecture Hydraulique, ascribes this invention to M. Bettancourt.



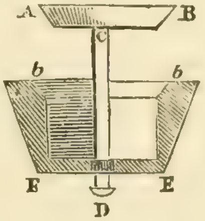
We shall add only another form of a perforated piston; which being on a principle different from all the preceding, will suggest many others; each of which will have its peculiar advantages. O O, in the figure, represents the box of this piston, fitted to the working-barrel in any of the preceding ways as may be thought best. A B is a cross-bar of four arms, which is fixed to the top of the box. C F is the piston-rod going through a hole in the middle of A B, and reaching a little way beyond the bottom of the box. It has a shoulder D, which prevents its going too far through. On the lower end there is a thick metal plate, turned conical on its upper side, so as to fit a conical seat P P in the bottom of the piston-box. When the piston-rod is pushed down, the friction on the barrel prevents the box from immediately yielding. The rod therefore slips through the hole of the cross-bars A B. The plate E, therefore, detaches itself from the box. When the shoulder D presses on the bar A B, the box must yield, and be pushed down the barrels, and the water gets up through the perforation. When the piston-rod is drawn up again, the box does not move till the plate E lodges in the seat P P, and thus shuts the water-



way; and then the piston lifts the water which is above it, and acts as the piston of a sucking-pump. This is a very simple and effective construction, and makes a very tight valve. It has been much recommended by engineers of the first reputation, and is frequently used; and, from its simplicity, and the great solidity of which it is capable, it seems very fit for great works. But it is evident that the water-way is limited to less than one-half of the area of the working-barrel. For if the perforation of the piston be one-half of the area, the diameter of the plate or ball E F must be greater; and therefore less than half the area will be left for the passage of the water by its sides.

We come now to consider briefly the forms which may be given to the *valves* of an hydraulic engine. The requisites of a valve are, that it shall be tight, of sufficient strength to resist the great pressures to which it is exposed, that it afford a sufficient passage for the water, and that it do not allow much to go back while it is shutting. Some engineers make their great valves of a pyramidal form, consisting of four clacks, whose hinges are in the circumference of the water-way, and which meet with their points in the middle, and are supported by four ribs which rise up from the sides, and unite in the middle. This is an excellent form, affording the most spacious water-way, and shutting very readily. It seems to be the best possible for a piston. The rod of the piston is branched out on four sides, and the branches go through the piston-box, and are fastened below with screws. These branches form the support for the four clacks. We have seen a valve of this form in a pump of six feet diameter, which discharged twenty hogsheads of water every stroke, and made twelve strokes in a minute, raising the water above twenty-two feet.

There is another form of valve, called the *button* or *tail valve.* It consists of a plate of metal A B (see the figure) turned conical, so as exactly to fit the conical cavity *b b* of its box. A tail C D projects from the under side, which passes through a cross-bar E F in the bottom of the box, and has a little knob at the end, to hinder the valve from rising too high. This valve, when nicely made, is unexceptionable. It has great strength, and is therefore proper for all severe strains, and it may be made perfectly tight by grinding. Accordingly it is used in all cases where this is of indispensable consequence. It is most durable, and the only kind that will do for passages where steam or hot water is to go through. Its only imperfection is a small water-way; which, from what has been said, cannot exceed, nor indeed equal, one-half of the area of the pipe. If we endeavour to enlarge the water-way, by giving the cone very little taper, the valve frequently sticks so fast in the seat that no force can detach them. And this sometimes happens during the working of the machine; and the jolts and blows given to the machine in taking it to pieces, in order to discover what has been the reason that it has discharged no water, frequently detaches the valve, and we find it quite loose, and cannot tell what has deranged the pump. When this is guarded against, and the diminution of the water-way is not of very great consequence, this is the best form of a valve.



Analogous to this is the simplest of all valves. It is nothing more than a sphere of metal, to which is fitted a seat with a small portion of a spherical cavity. Nothing can be more effectual than this valve; it always falls into its proper place, and in every position fits it exactly. Its only imperfection is the great diminution of the water-way. If the diameter of the sphere do not considerably exceed that of the hole, the touching parts have very little taper, and it is very apt to stick fast. It opposes much less resistance to the passage of the water than the flat under-surface of the button valve. The spherical valve must not be made too light, otherwise it will be hurried up by the water, and much may go back while it is returning to its place.

*Description of an Improved* PUMP *for Draining, constructed by Henry W. Reveley, Esq. Civil Engineer*, 33, *King-street, West, Bryanstone-square, London.*—The principal objects in the construction of this pump, are the following: "To obtain a machine of large dimensions, and of easy transportance; to afford sufficient scope for the most advantageous application of the united strength of many men, in raising large bodies of water to moderate heights, as required in draining large tracts of land, sinking foundations, &c. &c. To prevent, as far as possible, the choking, and final destruction, of the principal parts of the machine, by the impurities with which water, under such circumstances, is always loaded."

*Explanation of the Drawing.* (See Plate *Pump for Draining.*)—Fig. 1. Front elevation of the whole machine. *a, a,* the framework usually constructed of wood. *c, c,* the levers and hand-rails, by which the pumps are worked, as in the common fire-engine. *m, m,* two stages, or platforms, on which the men stand. *h, h,* the suction pipe, which branches out into two, at the upper part, in order to supply both the cylinders. This pipe is divided into short lengths by screw-joints, to suit various depths. *d, d,* the double rising-pipe, which communicates with the large cistern, or general receiver. *x, x,* the cistern, or general receiver, to which the rising-pipe, and pump cylinders, are firmly united. *f,* the delivering spout.

N. B. The same letters refer to the same parts in all the figures.

Fig. 2. A side section, shewing the internal construction of the whole. *o,* the suction valve. *p,* the rising valve. *r,* a small copper spring placed behind the rising-valve, in order to ensure its closing rapidly.

*Observation.*—The valves and their seats are of an oblong rectangular form, and are made entirely of metal, without any fitting whatsoever, so that they can never be out of order.

Fig. 3. A back view, with a section of one of the cylinders. *s, t,* the pump-arms, with their pistons attached in the common way.

Fig. 4. A side view. *n, n,* the spindle, to which the working levers and pump-arms are attached. *e,* one of the cylinders, or pump-barrels, which rise a few inches above the bottom of the cistern, to a sufficient height to prevent the dirt and stones, accumulated in the latter, from falling in, but not so high as to hinder the clear water from flowing into them, and keeping their pistons free and air-tight. *g,* a man-hole, through which, when necessary, the valves may be cleaned and examined. *q,* a plug, used for the double purpose of discharging the pump of its water, and cleaning the belly-part, from time to time, of the sand and gravel which are deposited there during the working.

Fig. 5. Is a plan of the whole machine, with its levers and hand-rails ready for work.

*General Observations.*—It is evident from this construction, that the water which is pumped up does not pass through the cylinders; it cannot, therefore, although loaded with sand and gravel, injure them in any sensible degree. The pistons, however, are constantly working between two waters, and remain perfectly free and air-tight. The machine, represented by this drawing, has the barrels of its pumps of the internal diameter of fourteen inches, and the length of each arm of its levers, eight feet. By placing six men outside, and four men within each hand-rail, the united strength of twenty men, acting at the extremity of a long lever, may be applied to working this pump; but in ordinary cases, where such an exertion is not requisite, half that number will be sufficient. The quantity of water raised by this pump, will vary according to the depth from which it is to be raised, and the power applied. It may be considered, however, in general, to raise from 2000 to 3000 cubic feet per hour.

*Description of a new and efficient Hydropneumatic* PUMP *for the Compression of Gasses.*—Lamps for condensed gas, are found so convenient and manageable in every respect, and oil-gas applied to the purpose of illumination is so preferable on various accounts to that made from pit-coal, that they are daily coming more and more into use. Independently of their adoption by private families, they are now employed in many shops, where the goods are of a nature to be injured by sulphurized hydrogen (always present in coal-gas,) and their use is extending among public institutions and large establishments about Town. Newgate has, for some months, been regularly lighted by means of portable gas lamps.

The establishment of the Portable Gas Companies was at first viewed in a dubious light, but time and experience have so far removed suspicion, that they now receive ample patronage. To render their establishment complete, there was nothing wanted, with the lamp, but such a condensing pump as we are now about to lay before our readers.

In consequence of the general use to which gas is likely to be brought when highly compressed, it becomes important to ascertain the best method of reducing it to that state, so that it shall be most useful and advantageous to the public. The present method of compressing gas is attended with a great many disadvantages; these principally consist of a considerable loss of gas during the operation of compression, an immense loss of power in consequence of the gas not being completely forced out of the pump barrel, and the excessive wear and tear of the machinery employed therein.

The pump which has hitherto been used for this purpose consists of a barrel well bored out, open at one end, as A, fig. 1. see plate *Hydro-Pneumatic Pump*, and *Bute's Furnace*,) with the two valves *c* and *d* at the other end; and the solid piston B working therein. This is, perhaps, the best possible arrangement of the piston pump, and is the one adopted by some of the first engineers and machinists.

Now, in the use of this pump it is impossible that the piston can be worked so close as to strike the bottom; there must be some space for clearance, otherwise there would be great danger of damaging the valves, or doing other mischief. Say, in a pump of 12-inch stroke and 5 inches' diameter, the spaces allowed between the bottom of the piston and the bottom of the pump shall be one-eighth of an inch, which is no great deal; now as the operation of compression goes on, this space will be gradually increased, and when the gas arrives at a pressure of 30 atmospheres, or 550 lbs. upon the square inch, (which is the average pressure employed by the Portable Gas Company,) there will then be the enormous weight of 9000 lbs. acting against the bottom of the barrel and the piston, which will naturally cause them to recede the one from the other; and from the actual spring of the cranks, the looseness and wear of bearings, spring of the connecting rods and crossheads, and even of the bottom of the pump itself, we may fairly conclude that under this great pressure the piston does not come within $\frac{1}{4}$ of an inch of the bottom; consequently there remains that quantity of gas under the great pressure of 30 atmospheres, which cannot be forced out, and which, as the piston recedes for the return stroke, will expand in the barrel, and occupy a great part of the space; thereby preventing the admission of another full charge And this is one of the greatest defects of this sort of pump; for allowing the space to be one quarter of an inch, it will be just one forty-eighth of the whole capacity of the pump; and adding to this the space left by the rising of the eduction valve *d*, which will remain open until the piston has receded a little in the return stroke, we may doubtless presume that a portion of compressed gas, equal in volume to one-fortieth of the whole stroke of the pump, remains behind every time in the barrel; therefore when the pump commences working, and the gas in the receiver arrives at a pressure of 10 atmospheres only, three fourths of the gas is forced out of the barrel,—at 20 atmospheres, one half,—at 30 atmospheres, one quarter;—and when it arrives at 40 atmospheres, the pump will cease to act, as the compressed gas which remains will expand itself, and fill the whole barrel; and therefore no more gas can then be admitted from the gasometer. Moreover, there is an actual loss of gas occasioned by the leaking of the piston, which is a failing that these pumps are more or less liable to; for, whether they be packed with metallic rings, cupped leathers, or hemp packing, still there will be some escape under this great pressure; and if the leathers, &c. are screwed up so hard as totally to prevent the escape of the gas, the friction will become immense, consequently one half of the power will be absorbed, and thus very little advantage would be gained by the remedy.

These observations will, it is presumed, place the defective operation of the common forcing pump in a clear point of view, and will naturally lead us to comprehend the advantages of the hydro-pneumatic pump. It will have been observed, that the great evil in the common pump is the space or cavity that is left when the piston is down at the bottom of the stroke. Now the remedying of such evil is the primary object sought for in this improvement; for this purpose a quantity of non-elastic fluid is introduced into the chamber of the pump, which, filling up the whole of the cavity when the piston is down, necessarily forces out every particle of the compressed gas; the method of accomplishing which will be readily understood in the description of the new pump.

Fig. 2 is an elevation, and fig. 3 a plan of the hydro-pneumatic pump. A A is a frame for supporting the machine; the pump consists of two chambers B and D; in the chamber B works the solid plunger C, through a cupped leather *v*, by means of the crank *n*, and the slings *m m*. D is the pneumatic chamber, at the top of which are placed the induction valve *e* and the eduction valve *c*: over the latter is placed a small vessel *g* with the pipe *h* leading to the receiver.

Now when the plunger C is at the bottom of the stroke as shewn in fig. 2, the pneumatic chamber D is then to be quite full of oil, or some other non-elastic fluid: and for further security, a small quantity of oil is also to be above the eduction valve *c*; when the plunger C is drawn back the oil in the chamber D will sink to the level of *r s*, and the space will then be filled with the gas, which will rush from the gasometer through the pipe *f* and valve *e*; but when the plunger is again forced down, the oil will rise to the same height as before, again filling up the whole capacity of the chamber D, and forcing out every particle of gas through the valve *c*; and so on alternately:

If, through the increased pressure, or from some other cause, the oil in the chamber D should not be quite sufficient to fill up the whole cavity on the return of the plunger, it is of no consequence, because the moment the valve *c* rises ever so little, the oil which was above the valve will descend, and displace the gas in the chamber D. The vessel *g* is a small reservoir for the oil, and to receive any drainage from the gas; the tube *k* is for ascertaining that the proper quantity of oil is in the apparatus, or for supplying more when required. It is possible that a trifling leak may take place through the valve *c*; but this will be of little consequence, as the escape of a small quantity of a non-elastic fluid back into the chamber D is not attended with the twentieth part of the inconvenience to which the escape of the same volume of compressed gas would be subject. Now, the particular advantage of this pump is, that the full charge of gas is forced through the valve *c* at every stroke of the piston, whether the pressure be equal to 1, 10, or 50 atmospheres. Indeed, there are no limits to the degree of compression of which this pump is capable; provided the parts of the machine be sufficiently strong to withstand the strain, and an adequate power be employed; while it is supposed that the operation of the common pump is not capable of extending beyond a pressure of 30 or 40 atmospheres.

A diagram may be constructed, which will furnish an easy method of ascertaining the power required to work the above pump sufficiently near for all practical purposes.

Thus let a straight line A B be divided into 32 equal parts, of which make $GB = 16$; $FG = 8$; $EF = 4$; $DE = 2$; $CD = 1$; and $AC = 1$. Then if we consider this whole line equal to the space which the plunger moves over in one stroke of the pump, it is plain that at B, the commencement of the stroke, the stroke will be equal to one atmosphere only, represented by a vertical line B *b*: but when the plunger has reached G, it will have made half a stroke, and the stroke will then be equal to two atmospheres, as shewn by a line $Gg = 2 \times Bb$. Again, when the plunger is at F, it will have made three-quarters of the stroke, and the force will then be equal to four atmospheres $= Ff = 4\,Bb$; and so on until the plunger arrives at C, when it will have made $\frac{31}{32}$ part of the stroke, and the compression and force will then be equal to 32 atmospheres, equal to a line $Cc = 32 \times Bb$. Therefore, if we consider *b g*, *g f*, *f e*, &c. as so many straight lines, then will the areas G *b*, F *g*, E *f*, D *e*, &c. be nearly as the momenta of the plunger passing over the several spaces B G, G F, F E, &c. But the several areas G *b*, F *g*, E *f*, &c. are all equal to each other; therefore the whole of the momenta of the plunger passing through the space B C, will be equal to five times the area G *g b* B; that is, equal to $5 \times \frac{\overline{gG + Bb} \times \overline{GB}}{2} = 5 \times 1\frac{1}{2} \times 16 = 120$.

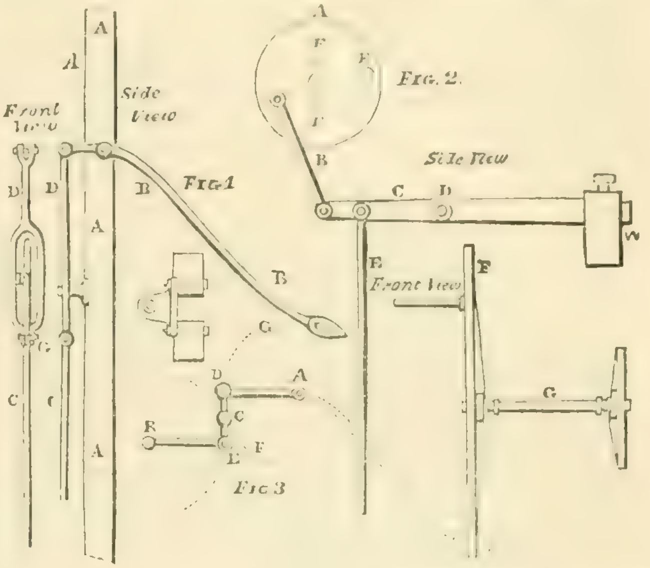
To this must now be added the momenta of the plunger passing from C to A, the last $\frac{1}{32}$d part of the stroke, which will be as 32 × 1 = 32;* which added to the above gives 152. We have now to deduct the pressure of one atmosphere, which has assisted the plunger in passing over the space B A; that is 32 × 1 = 32, which taken from the foregoing quantity will leave 120 for the whole absolute momenta of the plunger. Now, divide this quantity by the number of parts in the line A B (= 32,) and it will give 3¾ atmospheres, or 56¼ lbs. per square inch for the average force on the plunger during the whole stroke, when compressing gas equal to 32 atmospheres. Therefore as the pump acts but singly, if a fly-wheel of sufficient weight be employed, a power equal to about 30 lbs. on every square inch of the plunger will be nearly adequate to the working of the pump.

If gas of the pressure of only 20, or any other number of atmospheres less than 32, be required, the necessary average power for producing it can readily be ascertained from the same diagram; for let the line A *m* represent the proposed pressure, then cutting off the upper part of the figure by the line *m n*, parallel to the base A B; and calculating the remaining area in the manner already described, it will give the required power. And if the pressure should be required to be more than 32 atmospheres, then by increasing the height of the diagram towards *a c* in the manner already shewn, we can also in that case estimate nearly the necessary required power.

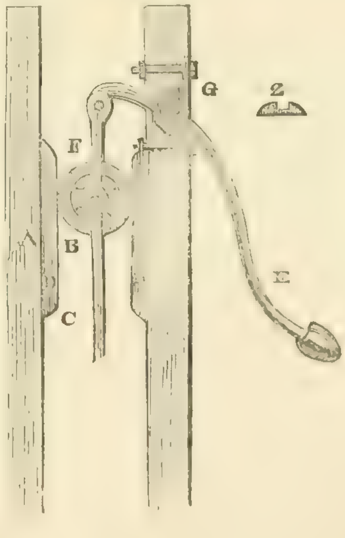
*Head*-Pump, a moveable pump, to put over the bows or side of a ship. These were formerly used in the navy, to pump water into the ship for washing the decks, &c. but since the invention of a cistern in the well, they are quite disused. *Pump-brake*, the wooden lever or handle by which a hand-pump is worked. *Pump-bolts*, two pieces of iron, with a knob at one end, and a hole for a pin or forelock in the other; one serves to fasten the pump-spear to the brake, and the other as a fulcrum for the brake to work upon. *Pump-dales*, long wooden tubes, extending from the chain-pumps across the ship, and through the side, serving to discharge the water without wetting the decks. *Pump-gear*, any materials requisite for fitting or repairing the pumps, as boxes, leather, &c. *Pump-spear*, that bar of iron, which, communicating with the upper box, is also attached to the end of the brake whereby the former is put in motion. *The Pump sucks*, is said of the pump when the water is drawn out, and there comes up nothing but froth and wind.

Pump *Chain*, consists of a long chain equipped with a sufficient number of valves a proper distances, which working upon two wheels, one above and the other below, passes downward through a wooden tube, and returns upward through another. it is managed by a long winch or roller, whereon several men may be employed at once, and thus it discharges in a limited time a much greater quantity of water than the common pump, and with less fatigue and inconvenience to the labourers.

Pump *Irons* of the following description have been made by some engineers, and they have answered very well when properly constructed. They are described in the 62d No. of the Mechanic's Magazine, thus:—Fig. 1 is the plan generally adopted for a common lifting pump. A is the pump standard, with the handle B connected to it; C the pump rod; D a sling, with a double joint at each end; the upper part of the pump rod C passes through a guide above the joint G, which always keeps the pump rod upright; the joints should be bushed with steel, and steel pins turned and fitted nicely, and they will last for many years without shaking in the least. But when I am confined for room, as is frequently the case, I use fig. 3, where A is the joint of the pump lever or handle; B a radius rod of the same length from B to E, as the pump lever from A to D; the ends D and E are connected by a link with three holes in it; the pump rod is slung to the middle hole, and by the radius rod and pump lever being fixed in the same vertical plane, the hole C will describe a straight line, or very nearly so, provided the arc F G does not much exceed 40 degrees. Fig. 2 is for deep wells, where the pump is obliged to be fixed in the well. The pump rod E is attached to a beam or lever C, which swings on a centre D; the connecting rod B is also jointed to the beam C at the extremity, the other end being fixed to the crank pin in the flange A, which has holes, marked to F F F, at different distances from the centre, in order that the quantity of water to be raised may be regulated by giving the pump rod E a longer or shorter stroke. The flange A is firmly fixed on a shaft with a fly-wheel at the other end, and a handle fixed to turn with the weight marked W at the outer end of the beam; C has a set screw at the top side, to allow it to be removed further off, or brought nearer to, the centre, as may be required. It should be placed so as to balance the weight of the pump rod, and half the column of water to be lifted. The inventor of this, fixed one pump, by which with the assistance of a wheel and pinion, one man with ease raised 7 gallons of water per minute from the depth of 120 feet.



*Improvement in Pump Irons.*—An improvement in the construction of pump irons, was invented by Mr. J Bennett, of Lincoln, about twelve months ago, and was so much approved as to be immediately adopted by the other plumbers in that city and its neighbourhood; and as it may be beneficial to others, we allow it a place in our Dictionary.



*Description.*—A A represent the front edges of the pump sides or standards; B, a cast iron friction wheel, 5½ inches diameter, for the purpose of keeping the bucket-rod C in a perpendicular direction; it works in two grooves made for that purpose, in two pieces of hard wood D D, which are fastened to the sides of the standards; (fig. 2 represents a section of those pieces); E the handle, which may either be of wood or iron; F connects the handle to the centre of the wheel by two steel bolts; G, a cast iron chair, in which is fastened a brass bush; two of these chairs are let into the side of the working standard, one on each side of the handle, and made fast by screw bolts and nuts. The handle has a fast axle, which works in the brass bushes, and which should be turned, and made to fit very exact, as should also the steel bolts. The motion will then be very steady, and the pump will last for years without getting out of repair.

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*Because, when the gas in the chamber is compressed equal to 32 atmospheres, it will then raise the valve, and make it escape into the receiver, as we suppose the pressure not to exceed 32 atmospheres.

Before quitting the article pump, we will describe the *Centrifugal Check Hooks,* invented by Mr. E. Spear, which formed part of an apparatus for the prevention of accidents in raising men or minerals out of mines, by means of a rope and bucket. The idea of centrifugal check-hooks appearing to be new, and applicable in other machines, for the purpose of stopping them when put into inordinate motion, or *running wild,* as the phrase is, the Society of Arts, &c. rewarded the inventor with their silver Vulcan medal, and directed that it should be inserted in their Transactions.

FIG. 1

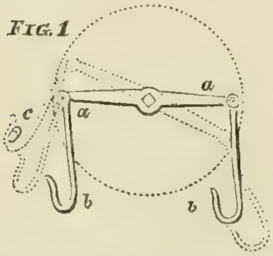


FIG. 2.

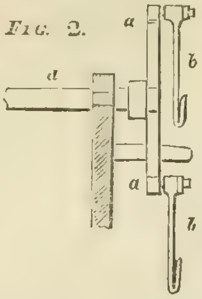


Fig. 1 is a front view, and fig. 2 is a side view, of the apparatus; *a a*, a bar fixed on the end of the axis *d*, fig. 2; *b b*, two hooks swinging freely on the ends of the same bar; *c*, a short bar projecting from the frame of the machine for the hooks to catch hold of. When the bar *a a* revolves moderately, the hooks *b b* hang down by their own gravify, and keep clear of the bar *c*, but when it revolves too quick, the centrifugal force causes them to diverge, as shewn by the dotted lines, and one of them catches hold of the check bar *c*, and stops the revolution of the axis entirely.

PUNCHEON, a little block or piece of steel, on one end whereof is some figure, letter, or mark engraved either in creux or relievo, impressions of which are taken on metal or some other matter by striking it with a hammer on the end not engraved. There are various kinds of these puncheons used in the mechanical arts; such for instance are those of goldsmiths, cutlers, pewterers, &c.

PUNCTUATION, the art of dividing a written composition into sentences, or parts of sentences, by points or stops, for the purpose of marking the different pauses which the sense requires.

PUNICA, the *Pomegranate Tree*, a genus of the monogynia order, in the icosandria class of plants, and in the natural method ranking under the 39th order pomaceæ. The calyx is quinquefid, superior; there are five petals; the fruit is a multilocular and polyspermous apple.—The fruit of the pomegranate is about the size of an orange, and has the general qualities of the other sweet summer fruits, allaying heat, quenching thirst, and gently loosening the belly. The rind is a strong astringent, and as such is occasionally made use of.

PUNT, a sort of flat-bottomed boat, whose floor resembles the platform of a floating stage. They are used in caulking, breaming, or repairing the bottom of a ship, and in shallow rivers.

PURCHASE, in Law, the buying or acquiring of lands, &c. with money, by deed or agreement, and not by descent or right of inheritance. A joint purchase is when two or more persons join together in the purchase.

PURCHASE, a name given to any sort of mechanical power employed in raising or removing heavy bodies, or in fixing or extending the ship's rigging; such are the tackles, windlasses, winches, capstans, screws, and handspikes.

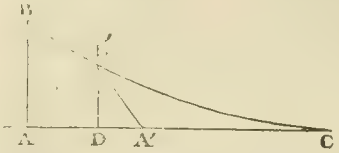
PURITAN, a name formerly given in derision to the dissenters from the church of England, on account of their professing to follow the pure word of God in opposition to all traditions and pure constitutions.

PURLINS, in Building, those pieces of timber that lie across the rafters on the inside, to keep them from sinking in the middle of their length.

PURPLE, a colour composed of a mixture of red and blue.

PURSER, an officer appointed by the lords of the admiralty to take charge of the provisions of a ship of war, and to see that they are carefully distributed to the officers and crew, according to the general printed naval instructions.

PURSUIT, CURVE OF, is one generated by the motion of a point, which is always directed towards another point also in motion along a right line, the velocity of the two points bearing any determinate ratio to each other. Thus let A and B be two bodies, the one A moving along the line A C, with any given velocity *v*; and the other B, moving with a velocity V, and in such a manner as to be always directed towards the body A, then is the curve B C thus described by B, the curve of chasee or the curve of pursuit.



PUS. The liquid called pus is secreted from the surface of an inflamed part, and usually moderates and terminates the inflammation.

PUTLOGS, or PUTLOCKS, in Building, are short pieces of timber about seven feet long, used in building scaffolds. They lie at right angles to the wall, with one of their ends resting upon it, and the other upon the poles which lie parallel to the side of the wall of the building.

PUTREFACTION. The decomposition of animal and vegetable matter, accompanied with a fœtid smell. The solid and fluid parts are changed in gaseous matter and vapours, and earthly particles remain. If animal or vegetable substances be congealed by hard frost, or made very dry and hard, so that no motion of their particles can take place, putrefaction is stopped.

PUTTY, in the Arts. When tin is melted in an open vessel, its surface soon becomes covered with a gray powder, which is an oxide of the metal. If the heat is continued, the colour of the powder gradually changes, and at last becomes yellow. In this state it is known by the name of putty, and employed in polishing glass and other hard substances.

PUTTY, is also a kind of paste compounded of whiting and linseed oil, beaten together to the consistence of a thick dough.

PUY DE DOMME, EXPERIMENT OF, a term under which the celebrated experiment of Pascal is commonly spoken of, and by which the gravity of the atmosphere was demonstrated beyond every possible objection. It was some time after Torricelli had first asserted the pressure of the atmosphere, before philosophers could divest themselves of their prejudices on this head; and various hypotheses were accordingly advanced to account for the suspension of the mercury in the tube, as stated in the Torricellian experiment. Even Pascal had his doubts on the subject. At length, however, he suggested that if the pressure of the atmosphere was the real cause of that suspension, the mercury ought to sink very sensibly on ascending a high mountain, and the Puy de Domme was selected for this purpose. On making the experiment, the result realized his expectation; the mercury having gradually sunk in the ascent where it was extremely obvious; and rose again, upon descending, to the same height as at first. No doubt could then any longer remain as to the real cause of the suspension, and it was accordingly universally admitted by every philosopher in Europe, and the name of the mountain was from that time transferred to the experiment, which is now usually called the Experiment of the Puy de Domme.

PUZZOLANA, or POZZULANA, a kind of earth found about Puteoli, Baiæ, and Cumæ, in the kingdom of Naples. It is thrown out from the burning mouths of volcanoes, in the form of ashes; sometimes in such large quantities, and with so great violence, that whole provinces have been covered with it to a considerable distance. Puzzolana is of a gray, brown, or blackish colour; of a loose, granular, or dusty and rough, porous or spongy texture, resembling a clay hardened by fire, and then reduced to a gross powder. It has various heterogeneous substances mixed with it. Its specific gravity is from 2·5 to 2·8; and it is, in some degree, magnetic; it scarcely effervesces with acids, though partially soluble in them. It easily melts *per se;* but its most distinguishing property is, that it hardens very suddenly when mixed with one-third of its weight of lime and water, and forms a cement which is more durable in water than any other. According to Bergman's analysis, 100 parts of it contain from 55 to 60 of siliceous earth, 20 of argillaceous, 5 to 6 of calcareous, and from 15 to 50 of iron. Its effects, however, in cement may, perhaps, depend only upon the iron, which has been reduced into a particular substance by means of subterraneous fires; evident signs of which are observable in the places where it is obtained.

**PYRAMID**, in Geometry, is a solid having any plane figure for its base, and triangles for its sides, all terminating in one common point or vertex. If the base of the pyramid is a regular figure, the solid is called a regular pyramid, which then takes particular names according to the number of its sides, as triangular, square, pentagonal, &c. the same as the prism. *See* Prism. If the perpendicular demitted from its vertex falls on the centre of the base, the solid is called a *right* pyramid, but if not it is *oblique*. The principal properties of the pyramid may be stated as follows:—1. Every pyramid is one-third of a prism of equal base and altitude. 2. Pyramids of equal bases and altitudes are equal to each other, whether the figure of their bases be similar or dissimilar. 3. Any section of a pyramid parallel to its base will be similar to the base, and these areas will be to each other as the squares of their distances from the vertex. 4. Pyramids, when their bases are equal, are to each other as their altitudes, and when their altitudes are equal they are to each other as their bases; and when neither are equal, they are to each other in the compound ratio of their bases and altitudes.

*To find the Solidity of a Pyramid.*—Multiply the area of the base by its perpendicular altitude, and one-third of the product will be the solidity.

*To find the Surface of a Pyramid.*—Multiply the perimeter of the base by the slant altitude of one of its faces, and half the product will be the surface. Or, find the area of one of its triangular faces, and multiply by the number of them, which is the same thing.

*Frustrum of a Pyramid*—Is the solid formed by cutting off the upper part of a pyramid by a section parallel to its base.

*To find the Solidity and Surface of a Frustrum of a Pyramid.*—Let A represent the area of the greater end, $a$ that of the less, and $h$ its height or altitude; also let S and $s$ represent the corresponding sides of the two ends, and $p$ the tabular number, answering to the particular figure of the base; then,

1. Solidity $= (A + \sqrt{Aa} + a) \times \frac{1}{3} h$
2. Solidity $= (S^2 + Ss + s^2) \times \frac{1}{3} p h$
3. Surface $= (S + s) \times n b$

where $n$ is the number of sides, and $b$ the slant height of the frustrum.

The pyramids of Egypt have been considered from time immemorial, among the most stupenduous wonders of the world; and no one can doubt that in strength and elevation they are superior to any other monuments that art can boast. Of these venerable buildings the most remarkable are the three pyramids of Memphis. The dimensions of the largest of them have been variously estimated. According to Greaves, its perpendicular elevation is 499 feet, and its oblique height 625 feet, which latter is the measure of its base. Its four faces look towards the four cardinal points of the compass: each face has a base of 110 fathoms, and each face forms an equilateral triangle. It results from these dimensions, and from the latitude under which this pyramid is raised, that, fourteen days before the spring equinox, (the precise epoch in which the Persians celebrated the renewing of nature,) it would cease to throw any shadow at mid-day, and that it would not project any shadow again (at mid-day) until fourteen days after the autumnal equinox; consequently, the day on which the sun's southern declination was 5 deg. 15 min. (which happened twice a year—once before the vernal equinox, and once after the autumnal equinox,) the sun would appear at mid-day precisely upon the very pinnacle of the pyramid. His majestic disk, placed upon that immense pedestal, would seem to repose upon it for some minutes, whilst his adorers, kneeling down at its foot, prolonging their view along the inclined plane of the northern face of the pyramid, contemplated the great Osiris, either as he descended into the shade of the tomb, or as he rose triumphant out of it. It would appear that the Egyptians, ever great in all their designs, had executed a project, the most daring which imagination could conceive, that of placing a pedestal for the sun and for the moon, or for Osiris and Isis, at mid day for the one, and at midnight for the other, when they arrived in that part of the heavens near which the line passes that separates the northern from the southern hemisphere, the reign of good from the reign of evil, the empire of light from the empire of darkness.—This pyramid covers upwards of eleven English acres, and may be ascended on the outside by about 208 steps. The symmetry of the work is equal to its durability, and in all probability these renowned fabrics will continue till the globe itself shall be dissolved.

**PYRITES**, a genus of inflammable substances, composed of sulphur which has dissolved or saturated itself with metals.

Pyrites, a native compound of metal, with sulphur.

**PYROLIGNEOUS ACID.** Pyroligneous acid, or what is generally termed vinegar of wood, is that which promises to be of most use as an animal antiseptic. From its low price it is adapted for general use; more particularly, as it not only preserves the food from putrefaction, but also gives it that smoky and acid taste peculiar to well-dried hams and red herrings. Indeed the only difference in using this acid, and drying by turf or wood smoke, seems to be merely the mode of operation; for in both cases this acid is the agent employed. In one case, the animal substance is acted on during the distillation of the acid; and in the other, the already-formed acid is applied to the substance by immersion.—This acid, the product of the distillation of wood, is now well known in Britain as an article of commerce, and in its native state is a liquid of the colour of white wine, possessing a strong acid and slightly astringent taste, combined with an empyreumatic smell. When allowed to remain in a state of rest for eight or ten days, tar of a black colour subsides, and the acid is then comparatively trasparent. Besides its antiseptic use, this acid is employed instead of acetate of lead by the calico printers, to make their acetate of alumina, or iron liquor. Though not very pure, it answers sufficiently well for blacks, browns, drabs, &c.; but for yellows and reds it is not so good, owing to the oil and tartar that is in combination with it.

**PYROMALIC ACID**, is obtained from the malic or sorbic acid, by distilling in a retort.

**PYROMETER**, a machine contrived to measure the expansion of metals and other bodies, occasioned by heat. Muschenbroeck was the original inventor of the pyrometer; the nature and construction of his instrument may be understood from the following account. If we suppose a small bar of metal, 12 or 15 inches in length, made fast at one of its extremities, it is obvious that if it be dilated by heat it will become lengthened, and its other extremity will be pushed forwards. If this extremity then be fixed to the end of a lever, the other end of which is furnished with a pinion adapted to a wheel, and if this wheel move a second pinion, the latter a third, and so on, it will be evident that by multiplying wheels and pinions in this manner, the last will have a very sensible motion; so that the moveable extremity of the small bar cannot pass over the hundredth or thousandth part of a line, without a point of the circumference of the last wheel passing over several inches. If this circumference then have teeth fitted into a pinion, to which an index is attached, this index will make several revolutions, when the dilatation of the bar amounts only to a quantity altogether insensible. The portions of this revolution may be measured on a dial plate, divided into equal parts; and by means of the ratios which the wheels bear to the pinions, the absolute quantity which a certain degree of heat may have expanded, the small bar can be ascertained; or, conversely, by the dilatation of the small bar, the degree of heat which has been applied to it may be determined. Such is the construction of Muschenbroeck's pyrometer. It is necessary to observe, that a small cup is adapted to the machine, in order to receive the liquid or fused matters, subjected to experiment, and in which the bar to be tried is immersed. When it is required to measure, by this instrument a considerable degree of heat, such as that of boiling oil or fused metal, fill the cup with the matter to be tried, and immerse the bar of iron into it. The dilatation of the bar, indicated by the index, will point out the degree of heat it has assumed, and which must necessarily be equal to that of the matter into which it is immersed. This machine evidently serves to determine the ratio of the dilatation of metals, &c.; for by substituting in the room of the pyrometric bar other metallic bars of the same length, and then exposing them to an equal degree of heat, the ratios of their dilatation will be shewn by the motion of the index.

Muschenbroeck has given a table of the expansion of the different metals in the same degree of heat. Having prepared cylindrical rods of iron, steel, copper, brass, tin, and lead, he exposed them first to a pyrometer with one flame in the middle; then with two flames; and successively to one with three, four, and five flames. But previous to this trial, he took care to cool them equally, by exposing them some time upon the same stone, when it began to freeze, and Fahrenheit's thermometer was at thirty-two degrees. The effects of these experiments are digested in the following table where the degrees of expansion are marked in parts equal to the $\frac{1}{12500}$ part of an inch.

It is to be observed of tin, that it will easily melt, when heated by two flames placed together. Lead commonly melts with three flames, placed together, especially if they burn long. From these experiments, so far as they are correct, it appears, at first view, that iron is the least rarefied of any of these metals, whether it be heated by one or more flames; and therefore is most proper for making machines or instruments which we would have free from any alterations by heat or cold, as the rods of pendulums for clocks, &c. So likewise the measures of yards or feet should, if of metal, be made of iron, that their length may be as nearly as possible the same, summer and winter.

| Expansion of ...... | Iron. | Steel | Copper | Brass. | Tin. | Lead |
|---|---|---|---|---|---|---|
| By one flame, | 80 | 85 | 89 | 110 | 153 | 155 |
| By two flames placed close together, | 117 | 123 | 115 | 220 | | 274 |
| By two flames 2½ inches distant, | 109 | 94 | 92 | 141 | 219 | 263 |
| By three flames placed close together, | 142 | 168 | 193 | 275 | | |
| By four flames placed close together, | 211 | 270 | 270 | 361 | | |
| By five flames, | 230 | 310 | 310 | 377 | | |

By the help of this instrument Mr. Ellicot found upon a medium, that the expansion of bars of different metals, as nearly of the same dimensions as possible, by the same degree of heat, were as follow.

| Gold, | Silver, | Brass, | Copper, | Iron, | Steel, | Lead. |
|---|---|---|---|---|---|---|
| 73 | 103 | 95 | 89 | 60 | 56 | 149 |

The great difference between the expansions of iron and brass has been applied with good success to remedy the irregularities in pendulums arising from heat. (Phil. Trans. vol. xlvii. p. 485.)

Mr. Graham used to measure the minute alterations, in length of metal bars, by advancing the point of a micrometer-screw, till it sensibly stopped against the end of the bar to be measured. This screw, being small and very lightly hung, was capable of agreement within the three or four thousandth part of an inch. On this general principle Smeaton contrived his pyrometer, in which the measures are determined by the contact of a piece of metal with the point of a micrometer screw.

The late Mr. Ferguson also invented two pyrometers, descriptions and figures of which are given in his Lectures.

Mr. Wedgwood, the ingenious manufacturer of the finest earthenware from basaltic masses, or *terra cotta*, has contrived a curious pyrometer: he employs small cubes of dry clay: because that species of earth has the remarkable property of contracting in its bulk, when submitted to the fire, and not again expanding on suddenly exposing it to the cold air. In order to ascertain the precise degree of heat in an oven, he puts one of his clay cubes into it, and after having acquired the temperature of the place, he immediately plunges it into cold water. Now, the size of the cube (that was exactly adjusted to half an inch square) is measured between two brass rules, the sides of which are somewhat obliquely disposed, so as to form an inclining groove, into which the cube may be slidden. In proportion as the bulk of the latter has been contracted by heat, it passes down deeper between the scales, on which the various degrees of temperature have been previously marked. Thus, when the division of the scale commences from the point of red heat visible in day-light, and the whole range is divided into 240 equal parts, it will be found that Swedish copper melts at 28; gold at 32; iron at from 130 to 150 degrees; above this point, the cubes could not be heated. But if one of these clay squares be put into an oven where other materials, such as bread, earthenware, &c. are to be baked, they may be usefully employed for regulating the necessary degree of heat. Perhaps, however, this gauge does not afford so constant and accurate a measure for the highest degrees of heat, as the dilation of mercury or of alcohol does for the lower.

PYROPHORUS. By this name is denoted an artificial product, which takes fire or becomes ignited on exposure to the air. Hence, in the German language, it has obtained the name of luft-zunder, or air tinder. It is prepared from alum by calcination, with the addition of various inflammable substances.

PYROTECHNY, is, properly speaking, the science which teaches the management and application of fire in divers operations; but in a more limited sense, and as it is more commonly used, it refers chiefly to the composition, structure, and use of artificial fire-works. The ingredients are, 1. saltpetre, purified for the purpose: 2. sulphur, and 3. charcoal. Gunpowder is likewise used in the composition of fire-works, being first ground, or, as it is technically termed, mealed. Camphor and gum benzion are employed as ingredients in odoriferous fire-works. The proportions of the materials differ very much in different fire-works, and the utmost care and precaution are necessary in the working them to a state fit for use, and then in the mixing. In this work we cannot enter on the subject with a sufficient degree of minuteness to teach the method of making of fire-works, and shall therefore content ourselves with the brief notice of the proportions of the materials in some of the more common and more interesting articles in use. The charges for sky-rockets are made of saltpetre, four pounds; brimstone, one pound; and charcoal one pound and a half; or by another direction, saltpetre, four pounds; brimstone one pound and a half; charcoal, twelve ounces; and meal powder, two ounces. These proportions vary again according to the size of the rocket: in rockets of four ounces, mealed-powder, saltpetre, and charcoal, are used in the proportions of 10, 2, and 1; but in very large rockets the proportions are saltpetre, four; mealed powder and sulphur one each. When stars are wanted, camphor, alcohol, antimony, and other ingredients, are required according as the stars are to be blue, white, &c. In some cases gold and silver rain is required; then brass-dust, steel-dust, saw-dust, &c. enter into the composition; hence the varieties may be almost indefinite. With respect to colour, sulphur gives a blue, camphor a white or pale colour, saltpetre a clear white yellow, sal-ammoniac a green, antimony a reddish, rosin a copper colour.

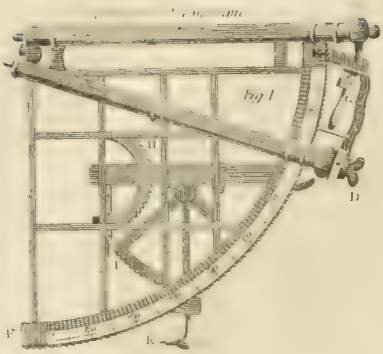
PYRUS, the *Pear Tree*, a genus of the pentagynia order, in the icosandria class of plants, and in the natural method ranking under the 36th order, pomaceæ. To this genus Linnæus has joined the apple and quince. There are thirteen species.

PYRUS *Cydonia.* (*The Quince.*) The seeds abound with a mucilaginous substance, of no particular taste, which they readily impart to watery liquors: an ounce boiled in three pints of water, will render it thick and ropy, like the white of an egg. A syrup and jelly of the fruit, and mucilage of the seeds, used to be kept in the shops.

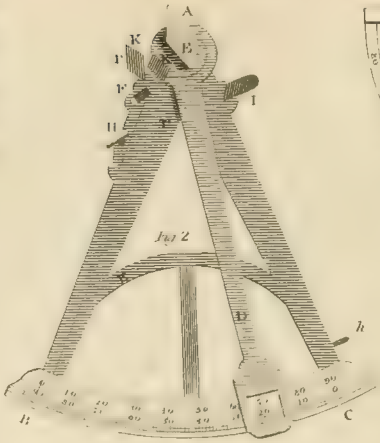
PYXIS NAUTICA, the *Sea Compass*, is of course, from its name, a modern constellation, since the instrument from which this asterism derives its title was unknown till the fourteenth century of our era. It is composed of a few stars, none of which exceed the fifth magnitude. Its place in the rigging of the constellation Argo renders its limits a matter of easy discrimination.

# QUADRANT & TELESCOPE.

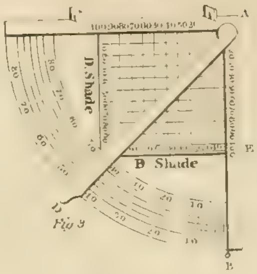
P.861 P.991

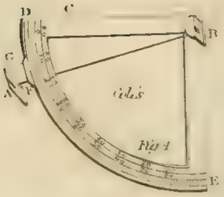


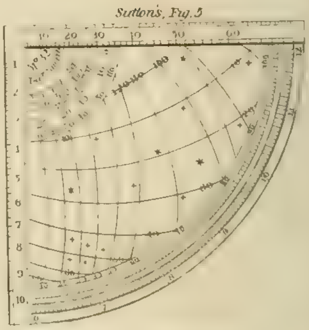
Hadley's Quadrant

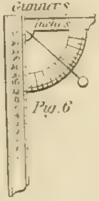


The Common

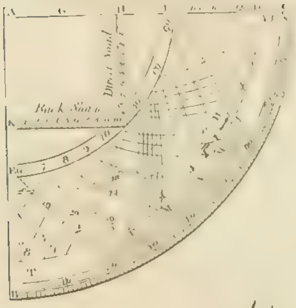




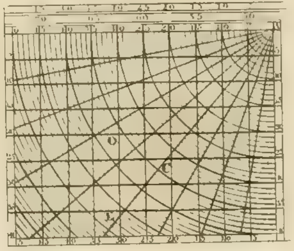




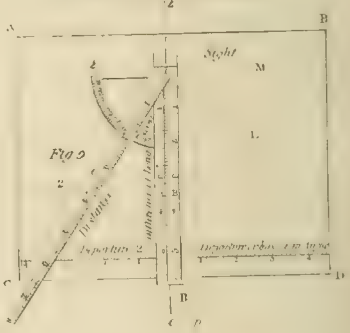
Gunters Quadrant Fig 7

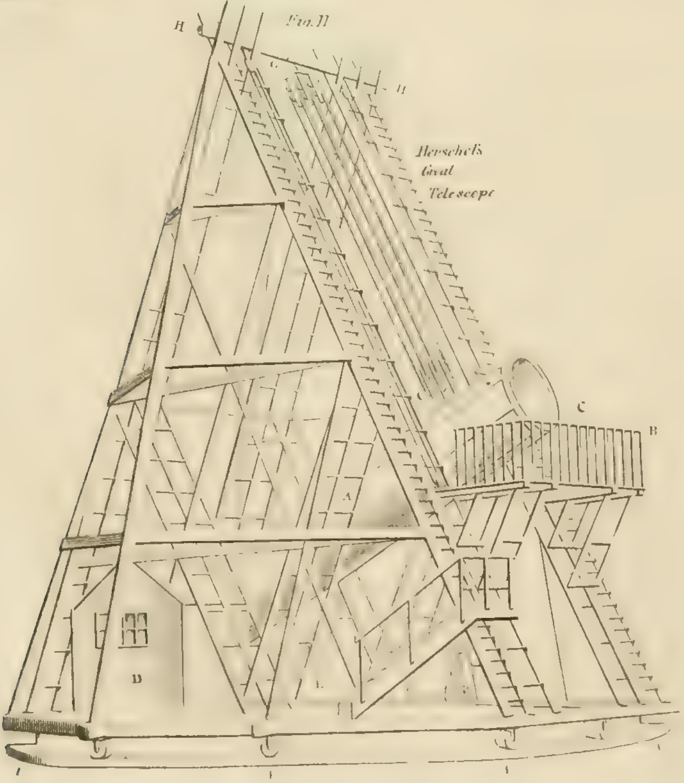


Sinical Fig. 8.

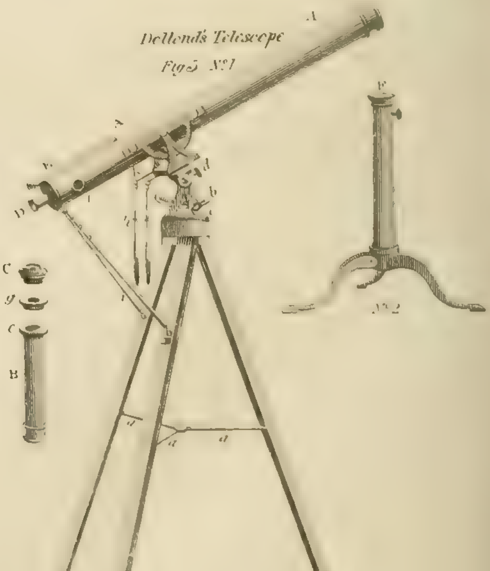


Quadrant & Practical Navigator





Dollond's Telescope
Fig 5 No 1



# Q.

Q, or q, the sixteenth letter of our alphabet. As a numeral it stands for 60; and with a dash over it, thus, $\overline{Q}$ for 500,000. Used as an abbreviature, q signifies quantity, or quantum; thus, among physicians, q. pl. is quantum placet, *i. e.* as much as you please of a thing; and q. s. quantum sufficit, *i. e.* as much as is necessary. Q. E. D. among Mathematicians, is *quod erat demonstrandum*, *i. e.* which was to be demonstrated; and Q. E. F. *quod erat faciendum*, *i. e.* which was to be done. Q. D. among Grammarians, is *quasi dictum*, *i. e.* as if it was said, or as, who should say. In the notes of the ancients, Q stands for *Quintus*, or *Quintius*; Q. B. V. for *quod bene vertat*; Q. S. S. S. for *quæ supra scripta sunt*; Q. M. for *Quintus Mutius*, or *quomodo*; *Quint.* for *Quintilius*; and *Quæs.* for *Quæstor.*

QUACK, a person pretending to practise medicine, without having been regularly or properly taught. In its more enlarged sense, this term includes all empirics, particularly those in divinity and law; but it is more generally restricted to those who, without an adequate degree of learning and knowledge, make pretensions to the healing art.

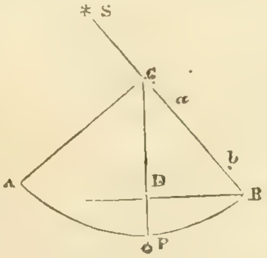
QUACKILTO, in Ornithology, the name of a beautiful Brazilian bird of the moor-hen kind. Its colour is of a fine blackish purple, variegated with white; and it imitates the crowing of the common cock.

QUADRANGLE, in Geometry, the same with a quadrilateral figure, or one consisting of four sides and four angles.

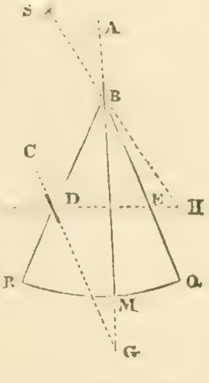
QUADRANS, the quarter or fourth part of any thing, particularly the Roman *as*, or pound.

QUADRANT, in Geometry, is either the quarter or fourth part of a circle, or the fourth part of its circumference; the arch of which, therefore, contains 90 degrees.

QUADRANT, also denotes a mathematical instrument, of great use in astronomy and navigation, for taking the altitudes of the sun and stars, as also taking angles in surveying heights and distances. There are several kinds of quadrants, which are commonly distinguished from each other, either by the names of their authors, or the purposes they are intended to answer. Thus we have *Adams's*, *Cole's*, *Davis's*, *Gunter's*, *Hadley's*, &c. QUADRANTS; as also the *Astronomical*, *Surveying*, &c. QUADRANTS. The principle upon which the construction and use of this instrument depends, may be illustrated by the annexed figure; A B C is a quarter circle of brass wood, or such like, having the arc A B divided into degrees and minutes, from A to B; on one side B C are fixed two sights *a*, *b*, and at C is fixed a plumb-line C P. Now to use the instrument, hold it so that the side of the quadrant B C is in a line with the object S, whose elevation is required, or so that it may be seen through the two small sights *a*, *b*; then the degrees, &c cut off by the plumb-line C P, measured from A towards B, will be the measure of the angle of elevation D B S, required for D B C, being a right-angled triangle, the two angles D B C and B C D, are together equal to a right angle, as are also the two B C D and D C A; from each of these therefore, taking away the common angle B C D, and there remains the angle D C A equal to the angle D B A. This is the most simple form of the quadrant, under which it is necessarily subject to very considerable inaccuracies, to remedy which a variety of forms have been given to it by different authors; but that of Hadley's is so decidedly superior to any other of a portable kind, that we shall limit our remarks principally to the description and use of this instrument; and a slight account of the astronomical and Gunter quadrants.



Before we attempt to describe the exact construction of this instrument, it may be of some use to the reader to illustrate the principles on which it rests, by a less complex figure than that of the quadrant itself. Though this instrument is usually called a quadrant, it is, in fact, but an octant, or 8th part of a circle, as Q B R, having a label or index B M moveable about B as a centre, and on this index, and in the same direction, is fixed a plane reflecting mirror, and on the side B R is placed another parallel to the other side B Q, but this is silvered only half way up, so that an object O may be seen directly through the plain part of the glass, from E, the sight vane. Now, an observer wishing, for example, to measure the angle subtended at H by the two objects O S, looks through the sight vane at E, and moves the index B M about its centre, till the reflected image of S is seen in the other reflector D, previously in conjunction with the object O, as seen through the plain glass; then the angle Q B M, or the arc Q M $= \frac{1}{2} \angle$ S H O, as may be thus demonstrated.



Since the angle of incidence is equal to the angle of reflection, $\angle ABS = \angle DBG = \angle HBG$; therefore B G bisects the angle H B D. Again, for the same reason, $\angle CDB = \angle HDG = \angle ODC$; therefore D C bisects the angle O D B. Now, $\angle ODB = \angle DBH + \angle BHD$, being the external angle of the triangle D B H, therefore $\angle CDB = \frac{1}{2} \angle DBH + \frac{1}{2} \angle DHB = \angle DBG + \frac{1}{2} \angle DHB$; but $\angle CDB = \angle DBG + \angle DGB$, therefore $\angle DGB = \frac{1}{2} \angle DHB$, or since C G and B Q are parallel, and $\angle DGB = \angle QBG$, the angle Q B G, or Q B M, is also equal to half D H B, or half O H S, which was to be shewn.

This is the principle on which the construction and use of this instrument depends; but its great and extensive utility in astronomical and nautical observations, renders it necessary now to enter into a more minute description. It may be observed, that in consequence of the points H and E not coinciding, there is a small error E H between the true and apparent angular point, which is called the *parallax of the instrument*; this, however, is *zero*, in celestial observations.

The *Astronomical* QUADRANT, is a large one, usually made of brass or iron bars; having its limb E F, fig. 1, (Plate *Quadrants*,) nicely divided, either diagonally or otherwise, into degrees, minutes, and seconds, if room will permit, and furnished either with two pair of plain sights or two telescopes, one on the side of the quadrant at A B, and the other C D moveable about the centre by means of the screw G. The dented wheels I and H serve to direct the instrument to any object or phenomenon. The application of this useful instrument, in taking observations of the sun, planets, and fixed stars, is obvious; for being turned horizontally upon its axis, by means of the telescope A B, till the object is seen through the moveable telescope, then the degrees, &c. cut by the index, give the altitude, &c. required.

*Description of Hadley's* QUADRANT.—This instrument consists of the following particulars; see plate, fig. 2. 1. An octant, or the eighth part of a circle, A B C. 2. An index D. 3. The speculum F. 4. Two horizontal glasses, F, G. 5. Two screens, K and K. 6. Two sight vanes, H and I.

The octant consists of two radii AB, AC, strengthened by the braces L, M, and the arch B C; which, though containing only 45°, is nevertheless divided into 90 primary divisions, each of which stands for degrees, and are numbered 0, 10, 20, 30, &c. to 90; beginning at each end of the arch, for the convenience of numbering both ways, either for altitudes or zenith distances; also each degree is subdivided into minutes, by means of a vernier. But the number of these divisions varies with the size of the instrument.

The index D is a flat bar, moveable about the centre of the instrument; and that part of it which slides over the graduated arch B C, is open in the middle, with a vernier scale on the lower part of it, under which is a screw serving to fasten it perpendicular to the plane of the instrument, the middle part of the former coinciding with the centre of the latter; and because the speculum is fixed to the index, the position of it will be altered by moving the index along the arch. The rays of an observed object are received on the speculum, and from thence reflected on one of the horizon glasses F or G; which are two small pieces of looking glass placed on one of the limbs, their faces being turned obliquely to the speculum, from which they receive the reflected rays of objects. This glass F has only its lower part silvered, and set in brass-work, the upper part being left transparent, to view the horizon. The glass G has, in its middle, a transparent slit, through which the horizon is to be seen. And, because the warping of the materials, and other accidents, may distend them from their true situation, there are three screws passing through their feet, by which they may be easily replaced.

The screens are two pieces of coloured glass, set in two square brass frames, K and K, which serve as screens to take off the glare of the sun's rays, which would otherwise be too strong for the eye: the one is tinged much deeper than the other; and as they both move on the same centre, they may be both or either of them used: in the situation they appear in the figure, they serve for the horizontal glass F; but when they are wanted for the horizon glass G, they must be taken from their present situation, and placed on the quadrant above G.

The sight-vanes are two pins H and I, standing perpendicular to the plane of the instrument: that at H has one hole in it, opposite to the transparent slit in the horizon glass G; the other, at I, has two holes in it, the one opposite to the middle of the transparent part of the horizon glass F, and the other rather lower than the quicksilvered part: this vane has a piece of brass on the back of it, which moves round a centre, and serves to cover either of the holes

*To rectify Hadley's Quadrant. For the Fore Observation.*—Bring the index close to the bottom, so that the middle of the vernier's scale, or nonius, stand against 0 degrees. Hold the plane of the instrument vertical with the arch downwards; look through the right-hand hole in the vane, and direct the sight through the transparent part of the horizon glass, to observe the horizon. If the horizon, seen both at the quicksilvered part, and through the transparent part, should coincide, or make one straight line, then is the glass adjusted; but if one of the horizon lines should stand above the other, slacken the screw in the middle of the lever backwards or forwards, as there may be occasion, until the lines coincide; fasten the screw in the middle of the lever, and all is ready for use.

*To take the Sun's Altitude.*—Fix the screens above the horizon glass, using either or both of them, according to the strength of the sun's rays, by turning one or both the frames of those glasses close against the plane or face of the instrument; then your face being turned towards the sun, hold the quadrant by the braces, or by either radius, as is found most convenient, so as to be in a vertical position, with the arch downwards. Put the eye close to the right-hand hole in the vane, look at the horizon through the transparent part of the horizon glass, at the same time sliding the index with the left hand, until the image of the sun, seen in the quicksilvered part, falls in with the edge of the horizon, taking either the upper or the under edge of the solar image. Swing your body gently from side to side; and when the edge of the sun is observed not to cut, but to touch the horizon line, like a tangent, the observation is made. Then will the degrees on the arch, reckoning from the end next your body, give the altitude of that edge of the sun which was brought to the horizon. If the lower edge was observed, then sixteen minutes, added to the said degrees, gives the altitude of the sun's centre; but if the upper edge was used, the sixteen minutes must be subtracted.

*To take the Altitude of a Star.*—Look directly up at the star through the vane and transparent part of the glass, the index being close to the button; then will the image of the star, by reflection, be seen in the silvered part, right against the star seen through the other part. Move the index forward, and as the image descends, let the quadrant descend also, to keep it in the silvered part, till it comes down in a line with the horizon, seen through the transparent part, and the observation is made.

*To rectify the Instrument for the Back Observation.*—Slacken the screw in the middle of the handle, behind the glass G; turn the button *h* on one side, and bring the index as many degrees before 0 as is equal to double the dip of the horizon at your height above the water; hold the instrument vertical, with the arch downwards; look through the hole of the vane H; and if the horizon, seen through the transparent slit in the glass G, coincide with the image of the horizon seen in the silvered part of the same glass, then the glass G is in its proper position; but if not, set it by the handle, and fasten the screw as before.

*To take the Sun's Altitude by the Back Observation.*—Put the stem of the screens K and K into the hole *r*, and in proportion to the strength or faintness of the sun's rays, let either one, or both, or neither of the frames of those glasses, be turned close to the face of the limb; hold the instrument in a vertical position with the arch downward, by the braces L and M, with the left hand; turn your back to the sun, and put one eye close to the hole in the vane H, observing the horizon through the transparent slit in the horizon glass G; with the right hand move the index D, till the reflected image of the sun be seen in the silvered part of the glass G, and in a right line with the horizon; swing your body to and fro, and if the observation be well made the sun's image will be observed to brush the horizon, and the degrees reckoned from C, or that part of the arch farthest from your body, will give the sun's altitude, at the time of observation; observing to add 16 for the sun's semidiameter, if the sun's upper edge be used, and subtract the same for the lower edge.

The directions just given, for taking the altitudes at sea, would be sufficient, but for two corrections that are necessary to be made before the altitude can be accurately determined, *viz.* one on account of the observer's eye being raised above the level of the sea, and the other on account of the refraction of the atmosphere, especially in small altitudes. The following tables therefore shew the corrections to be made on both these accounts; the first referring to the dip of the horizon; and the other to the refraction in altitude; the method of using which is given, in the following column.

TABLE I.—*Dip of the Horizon.*

| Height of the Eye in Feet. | DIP. | Height of the Eye in Feet. | DIP. | Height of the Eye in Feet. | DIP. |
|---|---|---|---|---|---|
| 1 | 0′ 57″ | 12 | 3′ 18″ | 35 | 5′ 39″ |
| 2 | 1 21 | 14 | 3 24 | 40 | 6 2 |
| 3 | 1 39 | 16 | 3 47 | 45 | 6 24 |
| 4 | 1 55 | 18 | 4 3 | 50 | 6 44 |
| 5 | 2 8 | 20 | 4 16 | 60 | 7 23 |
| 6 | 2 20 | 22 | 4 28 | 70 | 7 29 |
| 7 | 2 31 | 24 | 4 40 | 80 | 8 32 |
| 8 | 2 42 | 26 | 4 52 | 90 | 9 3 |
| 9 | 2 52 | 28 | 5 3 | 100 | 9 33 |
| 10 | 3 1 | 30 | 5 14 | | |

TABLE II.—*Refraction in Altitude.*

| Apparent Altitude in Degrees. | Refraction. | Apparent Altitude in Degrees. | Refraction. | Apparent Altitude in Degrees. | Refraction. |
|---|---|---|---|---|---|
| 0 | 33′ 0″ | 8 | 6′ 29″ | 40 | 1′ 8″ |
| ¼ | 30 35 | 9 | 5 48 | 45 | 0 57 |
| ½ | 28 22 | 10 | 5 15 | 50 | 0 48 |
| 1 | 24 29 | 11 | 4 47 | 55 | 0 40 |
| 2 | 18 35 | 12 | 4 23 | 60 | 0 33 |
| 3 | 14 36 | 15 | 3 30 | 65 | 0 26 |
| 4 | 11 51 | 20 | 2 35 | 70 | 0 21 |
| 5 | 9 54 | 25 | 2 2 | 75 | 0 15 |
| 6 | 8 29 | 30 | 1 38 | 80 | 0 10 |
| 7 | 7 20 | 35 | 1 21 | 85 | 0 5 |

*General Rules for the Corrections.*—1. In the fore observations, add the sum of both corrections to the observed zenith distance, for the true zenith distance; or subtract the said sum from the observed altitude for the true one. 2. In the back observation, add the dip and subtract the refraction for altitudes; and for zenith distances, do the contrary, *viz.* subtract the dip and add the refraction.

*Exam.* By a back observation the altitude of the sun's lower edge was found by Hadley's quadrant to be 25° 12″; the eye being 30 feet above the horizon. By the tables the dip on 30 feet is 5′ 14″, and the refraction on 25° 12′ is 2′ 1″. Hence

| | | | |
|---|---|---|---|
| Apparent alt. lower limb | 25° | 12′ | 0″ |
| Sun's semidiameter, sub. | 0 | 16 | 0 |
| Appar. alt. of centre | 24 | 56 | 0 |
| Dip of horizon, add | 0 | 5 | 14 |
| | 25 | 1 | 14 |
| Refraction subtract | 0 | 2 | 1 |
| True alt. of centre | 24 | 59 | 13 |

In the case of the moon, besides the two corrections above another is to be made for her parallax. But for all these particulars, see the requisite tables for the Nautical Almanac, &c.

QUADRANT, *the Common or Surveying.* This instrument, A B C fig. 3, is made of brass, or wood, &c.; the limb or arch of which B C is divided into 90 deg. and each of these is farther divided into as many equal parts as the space will allow, diagonally o. otherwise. To one of the radii A C are fitted two moveable sights; and to the centre is sometimes also annexed a label, or moveable index A D, bearing two other sights; but instead of these last sights there is sometimes fitted a telescope. Also from the centre hangs a thread with a plummet; and on the under side or face of the instrument are fitted a ball and socket, by means of which it may be put into any position. The general use of it is for taking angles in a vertical plane, comprehended under right lines going from the centre of the instrument one of which is horizontal, and the other is directed to some visible point. But besides the part above described, there is often added, on the face, near the centre, a kind of compartment E F, called a quadrant or geometrical square, which is a kind of separate instrument, and is particularly useful in altimetry and longimetry, and measuring heights and distances.

QUADRANT, *Cole's*, is a very useful instrument, invented by Mr. Benjamin Cole. It consists of six parts, *viz.* the staff A B, fig. 4; the quadrantal arch D E; three vanes A, B, C; and their vernier F G. The staff is a bar of wood about two feet long, an inch and a quarter broad, and of a sufficient thickness to prevent it from bending or warping. The quadrantal arch is also of wood, and is divided into degrees or third parts of degrees, to a radius of about nine inches; and to its extremities are fitted two radii, which meet in the centre of the quadrant by a pin, about which it easily moves. The sight-vane A is a thin piece of brass, near two inches in height and one broad, set perpendicularly on the end of the staff, A, by means of two screws passing through its foot. In the middle of this vane is drilled a small hole, through which the coincidence or meeting of the horizon and solar spot is to be viewed. The horizontal vane B is about an inch broad and two inches and a half high, having a slit cut through it of near an inch long and a quarter of an inch broad; this vane is fixed in the centre-pin of the instrument, in a perpendicular position by means of two screws passing through its foot, by which its position with respect to the sight-vane is always the same, their angle of inclination being equal to 45 degrees. The shade-vane C is composed of two brass plates. The one which serves as an arm is about 4½ inches long and ¾ of an inch broad, being pinned at one end to the upper limb of the quadrant by a screw, about which it has a small motion; the other end lies in the arch, and the lower edge of the arm is directed to the middle of the centre pin. The other plate, which is properly the vane, is about two inches long, being fixed perpendicularly to the other plate at about half an inch distance from that end next the arch; this vane may be used either by its shade, or by the solar spot cast by a convex lens placed in it. And because the wood work is often subject to warp or twist, therefore this vane may be rectified by means of a screw, so that the warping of the instrument may occasion no error in the observation, which is performed in the following manner: set the line G on the vernier against a degree of the upper limb of the quadrant; and turn the screw on the back side of the limb, forward or backward, till the hole in the sight-vane, the centre of the glass and the sunk spot in the horizon-vane, lie in a right line.

QUADRANT, *Collins's* or *Sutton's*, fig. 5, is a stereographic projection of one quarter of the sphere between the tropics, upon the plane of the ecliptic, the eye being in its north pole; and fitted to the latitude of London. The lines running from right to left, are parallels of latitude; and those crossing them are azimuths. The smaller of the two circles bounding the projection is one quarter of the tropic of Capricorn; and the greater is a quarter of the tropic of Cancer. The two ecliptics are drawn from a point on the left edge of the quadrant, with the characters of the signs upon them; and the two horizons are drawn from the same point. The limb is divided both into degrees and time; and by having the sun's altitude, the hour of the day may here be found to a minute. The quadrantal arches next the centre contain the calendar of months; and under them, in another arch, is the sun's declination. On the projection are placed several of the most remarkable fixed stars between the tropics, and the next below the projection are the quadrant and line of shadows.

QUADRANT, *Gunner's*, fig. 6, sometimes called gunner's square, is used for elevating and pointing cannon, mortars, &c. and consists of two branches either of wood or brass, between which is a quadrantal arch divided into 90 deg. and furnished with a thread and plummet.

QUADRANT, *Gunter's*, so called from its inventor, Edmund Gunter, (fig. 7,) besides the apparatus of other quadrants, has a stereographic projection of the sphere on the plane of the equinoctial; and also a calendar of the months, next to the divisions of the limb; by which, besides the common purposes of other quadrants, several useful questions in astronomy are easily resolved.

*Sinical* QUADRANT, is one of some use in navigation. It consists of several concentric quadrantal arches, divided into eight equal parts by means of radii, with parallel right lines crossing each other at right angles. Now any one of the arches, as B C, fig. 8, in the Plate, may represent a quadrant of any great circle of the sphere, but is chiefly used for the horizon or meridian. If then B C is taken for a quadrant of the horizon, either of the sides, as A B, may represent the meridian, and the other side A C will represent a parallel, or line of east and west; all the other lines parallel to A B will be also meridians; and all those parallel to A C, east and west lines, or parallels. Again, the eight species into which the arches are divided by the radii, represent the eight points of the compass in a quarter of the horizon; each containing 11 deg. 15 min. The arch B C is likewise divided into 90 deg., and each degree subdivided into 12 min., diagonalwise. To the centre is fixed a thread, which being laid over any degree of the quadrant, serves to divide the horizon. If the sinical quadrant is taken for a fourth part of the meridian, one side of it, A B, may be taken for the common radius of the meridian and equator; and then the other, A C, will be half the axis of the world. The degrees of the circumference, B C, will represent degrees of latitude; and the parallels to the side, A B, assumed from every point of latitude to the axis, A C, will be radii of the parallels of latitudes, as likewise the cosine of those latitudes. Hence, suppose it is required to find the degrees of longitude contained in 83 of the lesser leagues in the parallel of 48 deg.; lay the thread over 48 deg. of latitude on the circumference, and count thence the 83 leagues on A B, beginning at A; this will terminate in H, allowing every small interval four leagues. Then tracing out the parallel H E, from the point H to the thread, the part A E of the thread shews that 125 greater or equinoctial leagues make 6 deg. 15 min.; and therefore that the 83 lesser leagues A H, which make the difference of longitude of the course, and are equal to the radius of the parallel H E, make 6 deg. 15 min. of the said parallel. When the ship sails upon an oblique course, such course, besides the north and south greater leagues, gives lesser leagues easterly and westerly, to be re duced to degrees of longitude of the equator. But these leagues being made neither on the parallel of departure, nor on that of arrival, but on all the intermediate ones, there must be found a mean proportional parallel between them. To find this, there is on the instrument a scale of cross latitudes. Suppose then it were required to find a mean parallel between the parallels of 40 deg. and 60 deg.; take with the compasses the middle between the 40th and 60th degree on the scale; this middle point will terminate against the first degree, which is the mean parallel sought. The chief use of the sinical quadrant is, to form upon it triangles similar to those made by a ship's way with the meridians and parallels; the sides of which triangles are measured by the equal intervals between the concentric quadrants and the lines N and S E and W; and every 5th line and arch are made deeper than the rest. Now suppose a ship has sailed 150 leagues north-east by north, or making an angle of 33 deg. 45 min. with the north part of the meridian; here are given the course and distance sailed, by which a triangle may be formed on the instrument similar to that made by the ship's course; and hence the unknown parts of the triangle may be found. Thus, supposing the centre A to represent the place of departure, count by means of the concentric circles along the point the ship sailed on, *viz.* A A D, 150 leagues; then in the triangle A E D, similar to that of the ship's course, find A E = difference of latitude, and D E = difference of longitude, which must be reduced according to the parallel of latitude come to.

Quadrant and *Practical Navigator.* This newly-invented instrument has been described in the "Mechanics' Magazine." We presume, if it were completely made, it would be found very useful at sea for navigation, as any man might soon understand it; and also for many mechanics and schoolmasters, for demonstrating problems in some branches of the mathematics.

*Description.*—A B C D, fig. 9, in the Plate, represents a plain piece of board, with a place in the middle, *p p*, for the slide, A, to move up and down in. Q is a quadrant made fast upon scale B. By enlarging this quadrant to a semicircle, Q Q, the scales B and C, turning upon a centre, will set to solve all questions in oblique as well as plane trigonometry. B will turn off from scale A to any distance, as at L, the pricked line; and by sliding A upwards or downwards in the board, the scales will set to the given dimensions of any triangle whatever, and give both the plane and the true contents of all parts at the same time. By raising scale B to the pricked line, M, by a plummet hung at the centre, it becomes a good level; it will also give all the dimensions of a square. If you set slide A to the dimensions of one side of a square, set slide C to the same dimensions in the bottom scale, and C becomes the diagonal of the square. I have solved all the problems of practical navigation by this instrument, and a great number of promiscuous questions, with great ease and accuracy. The second horizontal line, C, and that next above it, represent a groove, wherein a quadrant, Q Q, slides, divided as the preceding; and by having two quadrants and the four scales to move upon the board A B C D, there will in all cases be three slides and two angles, which, I presume, will solve any question that can be proposed.

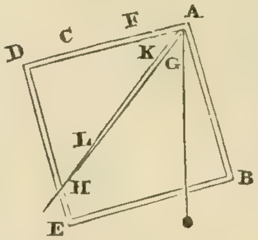
Quadrant *of Altitude*, is an appendix to the artificial globe, consisting of a thin slip of brass, the length of a quarter part of one of the great circles of the globe, and graduated. At the end, where the division terminates, is a nut riveted on, and furnished with a screw, by means of which the instrument is fitted on the meridian, and moveable round upon the rivet to all points of the horizon. Its use is to serve as a scale in measuring of altitudes, amplitudes, azimuths, &c.

QUADRANTAL, in Roman antiquity, a vessel every way square like a die, serving as a measure of liquids; its capacity was eighty libræ or pounds of water, which make 48 sextaries, two urnæ, or eight congii.

Quadrantal *Triangle*, a spherical triangle having a quadrant or an arc of 90° for one of its sides.

QUADRAT, in Printing, a piece of metal cast like the letters, to fill up the void spaces between words, &c. There are *m* quadrats, *n* quadrats, &c. which are respectively of the dimensions of these letters.

QUADRAT, a mathematical instrument, called also a geometrical square, and a line of shadows; it is frequently an additional member on the face of the common quadrant, as also on those of Gunter's and Sutton's quadrant; but we shall describe it by itself, as being a distinct instrument. It is made of any solid matter, as brass, wood, &c. of any four plain rules joined together at right angles, where A is the centre, from which hangs a thread with a small weight at the end, serving as a plummet. Each of the sides B E and D E, is divided into an hundred equal parts; or if the sides be long enough to admit of it, into a thousand parts; C and F are two sights fixed on the side A D. There is, moreover, an index, G H, which, when there is occasion, is joined to the centre A, in such a manner as that it can move freely round, and remain in any given situation; there are also two sights K L, perpendicular to the right line going from the centre of the instrument. The side D E is called the upright side, or the line of the direct or upright shadows; and the side B E is termed the reclined side, or the line of the versed or back shadows.



QUADRATURE, in Astronomy, that aspect of the moon when she is 90 deg. distant from the sun; or when she is in the middle point of her orbit, between the points of conjunction and opposition, namely, in the first and third quarters.

Quadrature *Lines*, are two lines placed on Gunter's sector, they are marked with Q. and 5, 6, 7, 8, 9, 10: of which Q. signifies the side of the square, and the other figures the side of the polygons of 5, 6, 7, &c. sides. S, on the same instrument, stands for the semi-diameter of a circle, and 90 for a line equal to 90 deg. in circumference.

QUADRILLE, a game at cards, sometimes called ombre by four; which chiefly differs from ombre by three, in being played by four persons; and having all the forty cards dealt out to each person, at ten each.

QUADRUPEDS, in Zoölogy, a class of land animals, with hairy bodies, and four limbs or legs proceeding from the trunk of their bodies; add to this, that the females of this class are viviparous, or bring forth their young alive, and nourish them with milk from their teats.

QUADRUPLE, a sum or number multiplied by four, or taken four times.

QUAGMIRE, in Agriculture, the name of a soft, miry, or shaking bog, swamp, or morass, which is frequently met with in low hollow situations, which affords but little declivity for the discharge of stagnant water.

QUAIL, in Ornithology, the least of all the birds of the gallinaceous kind. They have, however, the courage of the English cock, and may be brought to fight like game cocks. This was much practised among the Athenians, and is still kept up in some parts of Italy and Asia. The quail is a bird of passage, takes up its abode in corn fields, begins to sing in April, make its nest in May on the ground, and lays six or seven whitish eggs, marked with ragged rust-coloured spots.

QUAKERS. By stat. 7 and 8 W. III. c. 27, and 8 G. I. c. 6, Quakers making and subscribing the declaration of fidelity mentioned in 1 W. and M. shall not be liable to the penalty against others refusing to take such oaths: and not subscribing the declaration of fidelity, &c. they are disabled to vote at the election of members of parliament. By 7 and 8 W. III. c. 4, made perpetual by 1 G. I. c. 6, Quakers, where an oath is required, are permitted to make a solemn affirmation or declaration of the truth of any fact; but they are not capable of being witnesses in any criminal cause, serving on juries, or bearing any office or place of profit under government, unless they are sworn like other Protestants: but this clause does not extend to the freedom of a corporation. By stat. 22 G. II. c. 46, an affirmation shall be allowed in all cases (except criminal) where by any act of parliament an oath is required, though no provision is therein made for admitting a Quaker to make his affirmation. With respect to doctrine, Quakers are much divided: some being unitarians, and others believing the trinity.

**QUALITY**, that affection of a thing whence its denomination is derived. Hence, quality is said to be an attribute from which no substance is exempt. Qualities are of various kind, physical, intellectual, moral, primary, secondary, essential, relative, active, passive, &c. The term is applicable to animate and inanimate being.

**QUANTITY**, in Grammar, an affection of a syllable, whereby its measure, or the time wherein it is pronounced, is ascertained; or that which determines the syllable to be long or short. Quantity is also the object of prosody, and distinguishes verse from prose; and the economy and arrangement of quantities, that is, the distribution of long and short syllables, make what we call the number. The quantities are distinguished, among grammarians, by the characters ŏ, short, as per; and ō, long, as ros. There is also a common, variable, or dubious quantity; that is, syllables that are one time taken for short ones, and at another time for long ones; as the first syllable in *atlas*, *patres*, &c. Feet are made up of quantities. The quantity of syllables is known two ways. 1. By rules for that purpose. And, 2. By authority. The rules for this end are taught by that part of grammar called prosody; the authority made use of in this case is no more than examples from, or the testimony of, approved authors; and is never used but either when the rules are deficient, or when we are unacquainted with them.

**QUANTUM VALEBANT**, is where goods and wares sold are delivered by a tradesman at no certain price, or to be paid for them as much as they are worth in general; and the plaintiff is to aver them to be worth so much.

**QUANTUM** *Meruit*, in Law, is an action upon the case, founded on the necessity of paying a person for doing any thing as much as he deserves.

**QUARANTINE**, a trial which ships undergo when suspected of having on board persons infected with a pestilential disease. Physicians are occasionally consulted on this subject by government; who regulate this unpleasant restriction on the commerce of the country by their judgment, as to the period of time within which the effects of any infection, received by any individual on board, would be shewn. The usual quarantine is forty days. This may be ordered by the king, with the advice of the privy-council, at such times, and under such regulations, as he judges proper. Ships ordered on quarantine must repair to the place appointed, and must continue there during the time prescribed, without having any intercourse with the shore, except for necessary provisions, which are conveyed with every possible precaution. When the time is expired, and the goods opened and exposed to the air as directed, if there be no appearance of infection, they are admitted to port. Ships infected with the pestilence must proceed to St. Helen's Pool in the Scilly islands, and give notice of their situation to the custom-house officers, and wait till the king's pleasure be known. Persons giving false information, to avoid performing quarantine, or refusing to go to the place appointed, or escaping; also officers appointed to see quarantine performed, deserting their office, neglecting their duty, or giving a false certificate; suffer death as felons. Goods from Turkey or the Levant may not be landed without license from the king, or certificate that they have been landed and aired at some foreign port.

**QUARE**, in Law, a term affixed to the title of several writs.

**QUARRY**, the common name of an opening or pit dug into the earth, from which slate, marble, stones, and ores of various kinds, are to be raised, for purposes to which they are applicable.

**QUARTER**, in Law, the fourth part of a year; and hence the days on which these quarters commence are called quarter-days, *viz.* March 25, or Lady-day; June 24, or Midsummer-day; September 29, or Michaelmas; and December 21, or St. Thomas the Apostle's day. On these days rents on leases, &c. are usually reserved to be paid; though December 25, or Christmas-day, is commonly reckoned the last quarter-day.

**QUARTER**, the fourth part of any thing, the fractional expression for which is ¼. Quarter in weights, is generally used for the fourth part of a hundred weight avoirdupois, or 28 lb. Used as the name of a dry measure, quarter is the fourth part of a ton in weight, or eight bushels.

**QUARTER**, in Heraldry, is applied to the parts or members of the first division of a coat that is quartered, or divided into four quarters.

**QUARTER** *of a Point*, in Navigation, is the fourth part of the distance between two cardinal points, which is 2 deg. 48. min.

**QUARTER**, that part of a ship's side which lies towards the stern, or which is comprehended between the aft-most end of the main chains, and the sides of the stern, whence it is terminated by the quarter-pieces. Although the lines by which the quarter and bow of a ship, with respect to her lengths, are only imaginary, yet experience appears sufficiently to have ascertained their limits; so that if we were to divide the ship's sides into five equal portinos the names of each space would be readily enough expressed; thus the first from the stern would be the quarter; the second, abaft the midships; the third, the midships; the fourth, before the midships; and the fifth, the bow.

*On the* **QUARTER**, may be defined a point in the horizon, considerably abaft the beam, but not in the direction of the ship's stern. See the article BEARING.

**QUARTER** *Bill*, a list, containing the different stations to which the officers and crew are quartered in time of battle, with the names of the persons appointed to those stations.

**QUARTER** *Clothes*, long pieces of painted canvass, extended on the outside of the quarter-netting, from the upper part of the gallery to the gangway.

**QUARTER** *Gallery*. *See* GALLERY.

**QUARTER** *Master*, in the Navy, an inferior officer appointed to assist the mates in their several duties, as stowing the hold, coiling the cables, attending the steerage, and keeping time by the watch-glasses.

**QUARTER** *Master's Mate*, an officer under the preceding.

**QUARTER**-*Rails*, are narrow moulded planks, reaching from the top of the stern to the gangway, and serving as a fence to the quarter-deck.

**QUARTERING**, in Gunnery, is when a piece of ordnance is so traversed that it will shoot on the same line, or on the same point of the compass, as the ship's quarter bears.

**QUARTERING**, in Heraldry, in dividing a coat into four or more quarters or quarterings, by parting, couping, &c. that is, by perpendicular and horizontal lines, &c.

**QUARTERS**, imply the several stations where the officers and crew of a ship of war are posted in time of action. See the articles BATTLE, ENGAGEMENT, &c. The lieutenants are generally quartered on the different decks, to command the batteries; the master superintends the management of the ship; the boatswain and a sufficient number of men, are stationed to repair the damaged rigging; the gunner, usually on the lower gun-deck, and the carpenter, with his mates and crew, in the wings on the orlop. The marines are generally quartered on the poop and forecastle, or gangway, under the direction of their officers, although, on some occasions, they assist at the great guns, particularly in distant cannonading; and the great body of the seamen are stationed at the cannon or in the tops; while the captain is ever on the quarter-deck, giving directions to all around, and animating every one by his example.

The number of men appointed to manage the artillery is always in proportion to the nature of the guns, and the number and condition of the ship's crew. They are in general as follow, when the ship is full manned, so as to fight both sides at once occasionally: *Nature of the Guns*:—To a 42-pounder, 15 men; to a 32, 13 men; to a 24, 11 men; to a 18, 9 men; to a 12, 7 men; to a 9, 6 men; to a 6, 5 men; to a 4, 4 men; to a 3, 3 men. This number, to which is often added a boy, to bring powder to every gun, may be occasionally reduced, and the guns nevertheless well managed. The number of men appointed to the small arms:—1st rate 150 men to the small arms; 2d rate, 120 ditto; 3d rate of 80 guns, 100 ditto: 3d rate of 70 guns, 80 ditto; 4th rate of 60 guns, 70 ditto; 4th rate of 50 guns, 60 ditto; 5th rate, 50 ditto; 6th rate, 40 ditto; sloops of war, 30 ditto.

**QUARTERS**, is also an exclamation to implore mercy from a victorious enemy.

**QUARTERS** *of the Yards*, the space comprehended between the slings or middle, and the outer parts or the yard-arms.

**QUARTER** *Tackle*, a strong tackle fixed occasionally upon the quarter of the main-yard, to hoist heavy bodies in or out of the ship.

**QUARTER-SESSIONS.** The sessions of the peace is a court of record holden before two or more justices, whereof one is of the quorum, for the execution of the authority given them by the commission of the peace, and certain statutes and acts of parliament. The justices keep their sessions in every quarter of the year at least, and for three days if need be; to wit, in the first week after the feast of St. Michael, in the first week after the Epiphany, in the first week after Easter, and in the first week after St. Thomas, and oftener if need be. Any two justices, one whereof is of the quorum, by the words of the commission of the peace, may issue their precept to the sheriff, to summon a session for the general execution of their authority; and such session, holden at any time within that quarter of a year, is a general quarter-session, and the sheriff must summon a jury under their authority. There are many offences, which, by particular statutes, belong properly to this jurisdiction, and ought to be prosecuted in this court, as the smaller misdemeanors, not amounting to felony, and especially offences relating to the game laws, highways, alehouses, bastard children, the settlements and provision of the poor, vagrants, servants' wages, apprentices, and popish recusants. Some of these are proceeded upon by indictment, and others in a summary way, by motion and order, which may, for the most part, unless guarded against by any particular statute, be removed into the Court of King's Bench by certiorari, and be there either quashed or confirmed. The business done at quarter sessions has become of the highest importance to the country, and the public are greatly indebted to those magistrates who have sufficient knowledge of law to perform the duties of their office and give their attendance. In Ireland a practising barrister is appointed at each session to assist as chairman. In England this is not generally the case by law, but barristers are chiefly preferred, and the duty to be performed is so multifarious, that it requires no small skill in law, accompanied with much activity and industry, to execute it justly.

**QUARTZ,** a mineral of the flint genus, which is divided into five sub-species: *viz.* the amethyst, the rock-crystal, milk-quartz, common quartz, and prase.

**QUASSIA,** a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 14th order, gruinales. The calyx is pentaphyllous; there are five petals; the nectarium is pentaphyllous; there are from two to five seed-cases, standing asunder, and monospermous. There are three species, the amara, simaruba, and excelsa. The different species are much used in medicine, and by the brewers, to give a bitter taste to their beer.

**QUAY,** or Key, a place to land goods upon.

**QUEEN,** a woman who holds a crown singly. The title of queen is also given by way of courtesy to her that is married to a king, who is called by way of distinction queen-consort.

**QUERCITRON,** in Dying, the internal bark of the quercus nigra; it yields its colour, which is yellow, by infusion in water, and by the common mordants gives a permanent dye. *See* Dyeing.

**QUERCUS,** in Botany, the *Oak-tree*, a genus of the monœcia polyandria class and order. The wood of the oak, when of a good sort, is well known to be hard, tough, tolerably flexible, not easily splintering, strong without being too heavy, and not easily admitting water; for these qualities it is preferred to all other timber for building ships; it would be difficult to enumerate all the uses to which it may be applied. Oak saw-dust is the principle indigenous vegetable used in dyeing fustian; all the varieties of drabs and different shades of brown are made with oak saw-dust, variously managed and compounded. Oak apples are also used in dying, as a substitute for galls. *See* Cork.

**QUICK,** or Quickset Hedge, among Gardeners, denotes all live hedges, of whatsoever sort of plants they are composed, to distinguish them from dead hedges; but in a more strict sense of the word, it is restrained to those planted with the hawthorn, or cratagus oxyacantha, under which name these young plants, or sets, are sold by the nursery-gardeners, who raise them for sale.

**QUICKSAND,** a loose sand into which a ship sinks by her own weight, as soon as the water retreats from her bottom.

**QUICKSILVER.** *See* Mercury.

**QUICKWORK,** generally signifies all that part of a ship which is under water when she is laden; it is also applied to that part of the side which is above the sheer rail.

**QUILLS,** are the large feathers taken out of the end of the wings of geese, ostriches, crows, &c. They are denominated from the order in which they are fixed in the wing; the second and third quills being the best for writing, as they have the largest and roundest barrels. Crow quills are chiefly used for drawing.

**QUILTING,** a method of sewing two pieces of silk, linen, or stuff, on each other, with wool or cotton between them; by working them all over in the form of chequer or diamond work, or in flowers. The same name is also given to the stuff so worked.

Quilting, the operation of weaving a kind of coating formed of the strands of ropes about the outside of any vessel, to contain water, as a jar, bottle, &c.

**QUINCUNX,** in Roman antiquity, denotes any thing that consists of five-twelfth parts of another, but particularly of the *as*, or pound.

Quincunx *Order*, in Gardening, a plantation of trees, disposed originally in a square, and consisting of five trees, one at each corner, and a fifth in the middle; or a quincunx is the figure of a plantation of trees, disposed in several rows, both length and breadthwise, in such a manner, that the first tree in the second row commences in the centre of the square formed by the two first trees in the first row, and the two first in the third, resembling the figure of the five at cards.

**QUINDECAGON,** in Geometry, a plane figure with fifteen sides and fifteen angles, which, if the sides are all equal, is termed a regular quindecagon, and irregular when otherwise. The side of a regular quindecagon inscribed in a circle is equal in power to the half-difference between the side of the equilateral triangle, and the side of the pentagon inscribed in the same circle; also the difference of the perpendiculars let fall on both sides, taken together.

**QUINTAL,** in Commerce, the weight of a hundred pounds.

**QUINTESSENCE,** in the ancient chemistry, properly denoted the fifth essence, or the result of five successive distillations. This term was also used to express the highest degree of rectification to which any substance could be brought. Of late years it has become partially obsolete.

**QUIPOS,** in literary history, a name given knots or cords of various colours in Peru, which imperfectly supplied the place of writing. The different colours denoted distinct objects, and each knot expressed a different number.

**QUIRE,** of Paper, a quantity of 24 or 25 sheets.

**QUITAM,** in Law, is where an action is brought or an information exhibited, against a person, on a penal statute, at the suit of the king and the party or informer, when the penalty for breach of the statute is directed to be divided between them; in that case the informer prosecutes as well for the king as for himself.

**QUIT-CLAIM,** in Law, signifies a release of any action that one person has against another. It signifies also a quitting a claim or title to lands, &c.

**QUIT-RENT,** in Law, a small rent that is payable by the tenants of most manors, whereby the tenant goes quit and free from all other services. Anciently this payment was called white-rent, on account that it was paid in silver coin, and to distinguish it from rent-corn.

**QUOIN,** a wedge employed to raise the cannon to a proper level, that it may be more truly directed to the object. Also, a small wedge used by printers for fastening their pages in iron chases.

Quoins, are also employed to wedge off casks of liquids from each other, that their bilges may not rub so as to occasion a leak by the agitation of the ship at sea.

**QUOITS,** a kind of exercise or game, known among the ancients under the name of discus.

**QUO MINUS,** is a writ which issues out of the court of exchequer to the king's farmer or debtor, for debt, trespass, &c. Though this writ was formerly granted only to the king's tenants or debtors, the practice now is become general for the plaintiff to surmise, that by the wrong the defendant does him, he is the less able to satisfy his debt to the king, by which means jurisdiction is given to the court of exchequer to determine the cause. This writ is to take the body of the defendant, in like manner as the capias in the common pleas, and the writ of latitat in the king's bench.

**QUORUM**, a word which often occurs in our statutes, and is much used in commissions, both of justices of the peace and others, and so called from the words of the commission, *quorum unum esse volumus*, of whom we wish that A, B, &c. should be one. All magistrates are now of the quorum.

**QUO WARRANTO**, in Law, a writ which lies against a person or corporation that usurps any franchise or liberty against the king; as to have a fair, market, or the like, in order to oblige the usurper to shew by what right and title he holds or claims such franchise. This writ also lies for mis-user or non-user of privileges granted. The attorney general may exhibit a quo-warranto in the crown office against any particular persons, or bodies politic or corporate, who use any franchise or privilege without having a legal grant or prescription for the same, and a judgment obtained upon it is final, as being a writ of right.

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# R.

R, the seventeenth letter of our alphabet. In the notes of the ancients, R. or R O signifies Roma; R. C. Romana civitas; R. G. C. rei gerendæ causa; R. F. E. D. recte fractum et dictum; R. F. regis filius; R. P. res publica, or Romani principes; and R. R. R. F. F. F. res Romana ruet ferro, fame, flamma.

In the prescription of physicians, R or R, stands for recipe, i. e. take,

**RABBET**, a deep groove or channel, cut in a piece of timber longitudinally, to receive, the edge of a plank, or the ends of a number of planks, which are to be securely fastened therein. The depth of this channel is equal to the thickness of the plank, so that when the end of the latter is let into the rabbet, it will be level with the outside of the piece. Thus the ends of the lower planks of a ship's bottom terminate upon the stem afore and the stern post abaft, with whose sides their surfaces are even. The surface of the garboard streak, whose edge is let into the keel, is in the same manner level with the side of the keel at the extremities of the vessel.

**RABBETING**, in Carpentry, the planning or cutting of channels or grooves in boards. In ship carpentry, it signifies the letting-in of the planks of the ship into the keel; which in the rake and run of a ship, is hollowed away, that the planks may join the closer.

**RACE**, a particularly strong tide or current.

**RACK**, an engine of torture furnished with pulleys and cords, &c. for extorting confession from criminals. This instrument is happily banished from almost all christian countries.

**RACK**, a frame of timber containing several sheaves, and usually fixed on the opposite sides of a ship's bowsprit, to direct the sailors to the respective ropes passing through it.

**RACKING** *a Tackle*, the fastening two opposite parts together with a seizing, so as that any weighty body suspended thereby shall not fall down, although the tackle-fall should be loosened by accident or inattention.

**RADIAL CURVES**, are curves of the spiral kind, whose ordinates, if they may be so called, all terminate in the centre of the including circle, appearing like radii of that circle; whence the name.

**RADIANT POINT**, or **RADIATING** *Point*, is any point from which rays proceed.

**RADIATION**, the act of a body emitting or diffusing rays of light all round, and from a centre.

**RADICAL**, that which is considered as constituting the disdinguishing part of an acid, by its union with the acidifying principle, or oxygen, which is common to all acids. Thus sulphur is the radical of the sulphuric and sulphureous acids. It is called the base of the acid; but base is a term of more extensive application.

**RADICAL** *Sign*, (from *radix*, *root*,) in Algebra, is the character by which the root of a quantity is expressed, and is formed thus, $\surd$, while the particular root is indicated by a figure on the left of the sign: thus, $\sqrt[2]{a}$, $\sqrt[3]{a}$, $\sqrt[4]{a}$, &c. denote the square root, cube root, and biquadratic root of the quantity $a$, or of any other quantity placed under the like signs. When it is a compound quantity whose root is to be expressed, it is put in a parenthesis, and the sign prefixed; thus, $\sqrt[3]{}(a^2 + b^2,)$ means the cube root of the sum of $a^2$ *plus* $b^2$; or it is otherwise indicated by a line thus, $\sqrt[3]{a^2 + b^2}$; the characteristic $^2$ is generally omitted in the square root, so that instead of writing $\sqrt[2]{a}$ for the square root of $a$, we merely write $\sqrt{a}$, by which the square root is always to be understood.

**RADII**, the plural of RADIUS.

**RADIOMETER**, a name sometimes given to the FORE *Staff*.

**RADIUS**, in Geometry, the semi-diameter of a circle, or a right line drawn from the centre to the circumference. It is implied in the definition of a circle, and it is apparent from its construction, that all the radii of the same circle are equal. The radius is sometimes called, in trigonometry, the sinus totus, or whole sine. The length of the radius of any circle is equal to that of an arc of 67·2957795 degrees of the same circle.

**RADIX**, the same as root, but used in a different sense by different authors; thus we say, *radix* of a system of logarithms, a system of notation, &c. meaning the fundamental quantity on which the system is constructed, or by which all the others are compared.

**RADIX** of a *System* of *Logarithms*, is that number which involved to the power, denoted by the logarithm of a number, is equal to that number. This radix in the Common, or Brigg's Logarithms, is 10, and in the Naperian or Hyperbolic Logarithms, it is 2·71828182, &c. and generally the radix in any system of logarithms, is that number whose logarithm in that system is unity.

**RADIX** of a *System* of *Notation*, is that number which indicates the local value of the figures, and is in all systems represented by a unit and cipher (10), which is *ten* in the common system, *two* in the binary, *three* in the ternary, &c.

**RADIX**, is also used as a term of comparison between any finite function and its expansion or development; thus we know that $\frac{1}{1+r} = 1 - r + r^2 - r^3 + r^4 -$ &c. in which case $\frac{1}{1+r}$, is sometimes called the radix of the series $1 - r + r^2 - r^3 + r^4 -$ &c.

**RAFT**, a sort of float, formed by an assemblage of various planks or pieces of timber fastened together side by side, so as to be conveyed more commodiously to any short distance in a harbour or road than if they were separate.

**RAFT** *Port*, a square hole cut through the buttocks of some ships, immediately under the counter, to load or unload the planks and pieces of timber, which, on account of their great length, could not be got in or out otherwise.

**RAFTERS**, in Building, are pieces of timber, which, standing by pairs on the raising piece, meet in an angle at the top, and form the roof of a building.

**RAGG**, or **ROWLY**, a genus of stones belonging to the siliceous class. It is of a dusky or dark gray colour, with many small shining crystals, having a granular texture, and acquiring an ochry crust by exposure to the air.

**RAIA**, the *Ray*, in Natural History, a genus of fishes of the order cartilaginei. These fishes are found only in the sea, where they feed on whatever animal substances they meet with. They are sometimes of the weight of two hundred pounds. They conceal themselves for the greater part of the winter in the mud or sand of the bottoms, and, indeed, are seldom seen near the surface of the water. The female is larger than the male, and produces her offspring living, and only one at a time; the young extricating itself gradually from its confinement, and remaining some time attached by the umbilical vessels, after its complete appearance. There are nineteen species; the skate is one of the largest of the genus, weighing sometimes two hundred pounds, and one of the size is reported to have been served up at St. John's College, Cambridge; it is the most esteemed species of the genus. The thorn-back is much inferior to the skate in size and goodness. It is distinguished by its long and curved spines, on its upper surface. The above are rhomboidal. The sting-ray inhabits the Indian and Mediterranean seas, and its tail is armed with a very long serrated spine, with which it can inflict very formidable wounds, and which it casts off every year. This was formerly supposed to contain the most subtle poison. It injures, however, only by piercing and laceration; and to prevent this, the tail is almost always cut off as soon as the fish is caught. The torpedo inhabits the Mediterranean and the North seas, and grows to the weight of twenty pounds. This fish possesses a strong electrical power, and is capable of giving a very considerable shock through a number of persons forming a communication with it. This power was known to the ancients, but exaggerated by them with all the fables natural to ignorance, and it is only recently that the power was ascertained to be truly electric. It is conducted by the same substances as electricity, and intercepted by the same. In a minute and a half no fewer than fifty shocks have been received from this animal, when insulated. The shocks delivered by it in air are nearly four times as strong as those received from it in water. This power appears to be always voluntarily exercised by the torpedo, which occasionally may be touched and handled without its causing the slightest agitation. When the fish is irritated, however, this quality is excercised with proportional effect to the degree of irritation, and its exercise is stated in every instance to be accompanied by a depression of the eyes.

**RAIL**, or **Water Rail**, in Ornithology, the name of a bird of a long slender body, with short concave wings. The legs of this bird are placed very far behind, and are of a dusky flesh colour. Its toes are very long, and though the feet are not webbed, it takes the water, swims with ease, and is often observed to run apparently along its surface. It delights less in flying than in running, which it does very swiftly along the margins of brooks covered with rushes. In running, it occasionally flirts up its tail; and in flying, its legs hang down. Pennant says, that it is an unique species.

**Rail** *Land*, in Ornithology, is a migrating bird. It has a short, strong thick bill, and is generally found among corn, grass, broom, or furze. It leaves this kingdom before winter. It abounds in Anglesea, where it appears about the middle of April, and is supposed to come from Ireland. Of the Hebrides and Orkneys it is generally an inhabitant.

**RAILING**, in Rural Economy, is a sort of fence constructed with posts and rails. It is frequently used to protect young hedge fences and trees from the depredations of cattle or other animals.

**RAILLERY**, Dr. Johnson has defined to be a slight satire or satirical merriment; and another writer has compared it to a light that dazzles, but does not burn. It is serious, severe, and good-humoured, and if it perplexes it should never offend.

**RAILWAY**, *Tram* or *Dram Road*, in Rural Economy, is a track constructed of wood, stone, or other materials, but chiefly of iron, upon the level surface of an inclined plane, or in other situations, for the purpose of diminishing friction, and for the more easy conveyance of heavy loads of any kind of articles. Until very lately, rail roads were chiefly confined to mines of various descriptions, but they are now coming into more general use, and are capable of being applied with advantage to many roads on which they have never yet made their appearance. In Derbyshire, Shropshire, Lancashire, and several other counties, they are very numerous, some of them extending several miles. At first timbers were laid down, on which flat bars of iron were nailed. This was afterwards succeeded by cast iron of sufficient thickness, and the timber was dismissed. The benefits arising from these rail roads have given rise to numerous calculations. Dr. Anderson estimates, that upon a perfect level, one horse of moderate strength can draw with ease from twelve to twenty tons. On inclined planes, where the ends of canals cannot be brought to join the sea without many locks, they might be employed with the greatest success. Instead of loading any pair of wheels with an enormous weight which would tend to crush the road over which they pass, it has been found by experience more beneficial to employ a string of carriages, that the pressure may be distributed. Near Colebrook Dale there is a rail road, on which loaded boats are drawn up to a canal two hundred and twenty feet above the level of the Severn, and let down into it in a similar manner, by which means twenty-two locks are saved, and the work is executed in a more expeditious manner. This is supposed to be the greatest inclined plane in Europe, or perhaps in the world; for though they are much used in China in the place of locks, none of them are equal in height and acclivity to this.

**RAIN.** This phenomenon some philosophers have attributed entirely to the influence of the electric fluid, and this explanation has been rendered the more probable by the circumstance of most abundant showers usually accompanying a thunder storm. It is worthy observation, that much the greatest quantity of rain falls in that time of the year when the air appears clearest, and when, from the heat, the appearance of moisture on the ground soon disappears; also, that in warmer countries than ours, and where the air appears much clearer, the quantity of rain which falls greatly exceeds that in this country. Very frequently rain is produced by the concussion or condensation of two clouds, the one positively and the other negatively electrified; and this has been proved by experiment with a kite elevated to a great height in the air. There is no necessity to maintain that rain can never be produced in any other manner. The mean annual quantity of rain is greatest at the equator, and decreases gradually as we approach the poles. Thus, at Grenada, West Indies, it is 126 inches; Cape Francois, 120: Calcutta, 81; Rome, 39; England, 35; Petersburgh, 16.

The number of rainy days is smallest at the equator, and increases in proportion to the distance from it. The mean number from north latitude 12° to 43°, being 78; from 43° to 46°, being 103; from 46° to 50°, being 134; from 51° to 60°, 161. The number of rainy days is often more in winter than in summer; but the quantity of rain is greater in summer than in winter. According to an observation made in England, if two vessels of equal extent be exposed at different heights, and the quantity of water which falls into them during any considerable time, for instance, a year, be measured, it is found that the vessel at the greater height receives less water. This seems to point out that the drops of rain become larger as they fall, by the precipitation of the watery vapours which they encounter; and that in lowering the temperature of the space which they traverse, they cause these vapours to precipitate more abundantly. This experiment, repeated at the observatory at Paris, gave the same result. A necessary consequence is, that, in general, more rain falls in the valleys than on the hills.

The quantity of rain which has fallen in different places has been accurately observed, and from which it appears, that much depends upon local situation. The quantity of rain which fell at Paris in the course of a year, taken at a medium of six years, was 20·19 inches; and in London, the medium quantity per annum, for the same number of years, was 23·001. Much, however, depends upon the height of the rain-gage from the surface of the earth, more than upon the comparative altitudes of it with reference to the surface of the sea, or any fixed point; the rain-gage on the top of a mountain, giving nearly as much as that in the plain beneath; whereas, one gage placed on the top of a house or church, and another below, give very different quantities. The following table exhibits the results of several very accurate observations made on three gages, one at the bottom of a house, another at the top of the same, and a third on Westminster Abbey, the greatest care being taken that none of the water should evaporate after it entered the gage, by passing it through a narrow tube into a bottle well stopped below.

From these results it will appear, that there fell below the top of a house above a fifth part more rain than what fell in the same space above the top of the same house. And that there fell upon Westminster Abbey not much above half what was found to fall in the same space below the tops of the houses. This experiment has been repeated in other places with the same result; and, notwithstanding the cause of this extraordinary difference has not yet been discovered, it is at the same time useful to be apprised of it, to prevent any inaccurate conclusions from a comparison of different gages.

*The Quantity of Rain which fell in London from July 7, to July 6 in the succeeding Year.*

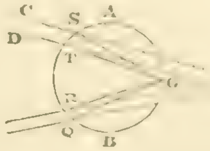
| MONTHS. | Lower Gage of a House. | Middle Gage, Top of a House. | Upper Gage on Westminster Abbey. |
|---|---|---|---|
| | *Inches.* | *Inches.* | *Inches.* |
| From July 7th to the 31st. | 3·591 | 3·210 | 2·311 |
| August,................. | 0·558 | 0·479 | 0·508 |
| September,.............. | 0·421 | 0·344 | |
| October,................ | 2·347 | 2·061 | 1·416 |
| November,............... | 1·079 | 0·842 | 0·632 |
| December,............... | 1·612 | 1·258 | 0·994 |
| January,................ | 2 071 | 1·455 | 1·035 |
| February,............... | 2·861 | 2·494 | 1·335 |
| March,.................. | 1·807 | 1·303 | 0 587 |
| April,.................. | 1·437 | 1·213 | 0·994 |
| May,.................... | 2·432 | 1·745 | 1·142 |
| June,................... | 1·997 | 1·426 | 1·145 |
| July 7.................. | 0·395 | 0·309 | |
| | 22·608 | 18·139 | 12·099 |

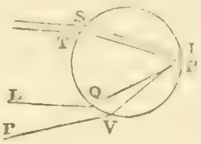
The following *Table* exhibits similar Experiments, made on two Gages, one on the Top of Mount Rennig, in Wales, and another in the Plain 1350 feet below the other.

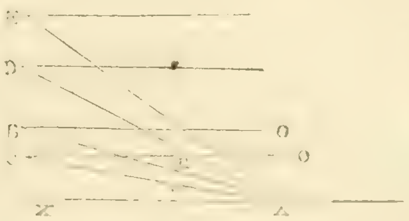
| | Bottom of the Mountain. | Top of the Mountain. |
|---|---|---|
| | *Inches.* | *Inches.* |
| From July 6 to 16,......... | 0·709 | 0·648 |
| July 16 to 29,......... | 2·185 | 2·124 |
| July 29 to Aug. 10,.... | 0·610 | 0·656 |
| Sept. 9, both bottles had run over. | | |
| From Sept. 9 to 30,......... | 3·234 | 2·464 |
| Oct. 17, bottles run over. | | |
| From Oct. 17 to 22........... | 0·747 | 0·885 |
| Oct. 22 to 29,............... | 1·281 | 1·388 |
| | 8·766 | 8·165 |

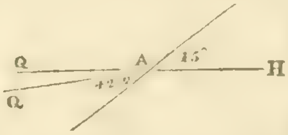
These experiments justify the assertion made above, *viz.* that the quantity of rain, in any place, depends principally upon its altitude above the surface of the earth, and not much upon the comparative altitude of two places with regard to the surface of the sea, and consequently not upon the rarity or density of the atmosphere, as was for a long time supposed by philosophers.

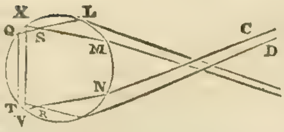
**RAINBOW.** The rainbow is a circular image of the sun variously coloured. It is thus produced; the solar rays, entering the drops of falling rain, are refracted to their farther surfaces, and thence by one or more reflections transmitted to the eye. At their emergence from the drop, as well as at their entrance, they suffer a refraction, by which the rays are separated into their different colours, and thus, therefore, are exhibited to an eye properly placed to receive them. That this is the true account of the formation of the rainbow, appears from the following considerations. 1. That a bow is never seen but when rain is falling, and the sun shining at the same time, and that the sun and bow are always in opposite quarters of the heavens; this every one's experience can testify. 2. That the same appearance can be artificially represented by means of water thrown into the air, when the spectator is placed in a proper position with his back turned to the sun: Let A B be a drop of water, and C D a pencil of solar rays incident thereon; if all the rays of any one colour, as red, belonging to the pencil C D, be refracted to the same point G, and thence reflected, they will fall on the space R Q, with the same obliquity and at the same distances from each other, as the refracted rays, if proceeding backward from G, would fall on the space T S; but these at their refraction would emerge into T D, C S, &c. parallel to each other, and therefore will enter an eye properly placed copiously enough to cause a sensation; a red colour will therefore appear in the direction of these rays, and so of others. But if the refracted rays do not meet in the same point, the reflected rays will not fall on the surface, at the same distance from each other, as P T and I S do, though their obliquity to the surface be equal to that of the latter: therefore the refracted rays will emerge, diverging from each other, and consequently will not enter the eye copiously enough to cause a perception of their colour. It is plain that where the rays of any colour emerge parallel, all these emerging rays will be inclined to the incident rays in the same angle. And by calculation it is found, that the red rays when they emerge parallel to each other, make with the incident rays an angle, A B O, of 42° 2′, and the violet an angle, A C O, of 40° 17′, and the rays of the other colours angles greater than the latter, and less than the former. If through the eye which receives the emerging rays, there be drawn a line A X, parallel to the incident rays, it will make with the emerging rays of each colour, angles R A X, and V A X, &c. equal to the above. This line A X is called the axis of vision. The several drops placed in the lines A R, A V, &c. will exhibit to the eye at A, the several prismatic colours respectively, as appears from what has been said; and if those lines be supposed to revolve with a conical motion round the axis of vision, it is evident for the same reason, that all the drops placed in each of the conic surfaces so generated, will transmit the rays of each colour respectively to the eye, and therefore that a number of circular concentric arches of the prismatic colours adjoining to each other, will be exhibited to the eye. This explanation relates to the interior bow, whose colours beginning from the outside, are red, orange, &c. as in the prismatic spectrum, which bow can never be seen if the sun be elevated more than 42° 2′ above the horizon; for the horizon H O always makes with the axis of vision, A X, an angle equal to the elevation of the sun; therefore in the case here stated, the line A Q, marking the vertex of a rainbow, would fall entirely below the horizon. As the interior bow is formed by one reflection and two refractions, so the exterior bow is formed by two reflections and two refractions, at the surfaces of the drops of falling rain. If the red ray of any









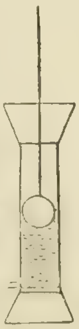


pencil, CD, of solar rays, after refraction, intersect each other at R, so that when reflected at T V, they may proceed parallel within the drop, after a 2d reflection at XQ, they will proceed to LM, intersecting each other at S, equally distant from XQ, as R is from T V, and as the rays Q T, X V, if they proceeded backward, would after reflection so fall on the surface, N O, as to be refracted into air parallel to each other; so X M, Q L, falling on the surface precisely in the same circumstance, shall be refracted to the eye parallel to each other, and therefore will enter it copiously enough to cause a perception of their colour, (and so of the rest). The red rays, when emerging parallel after two reflections, are by calculation found to make with the incident rays, and therefore with the axis of vision, an angle of 50° 57′. The violet rays, when emerging parallel, are found to make with their incident rays, and therefore with the axis of vision, an angle of 54° 7′: the other emerging rays meet the axis of vision in the intermediate angles. And hence it is easy to explain the generation of the exterior bow in the same manner as that of the interior. It is to be remarked, that the order of colours in the exterior bow is the reverse of that in the interior, and the reason of this appears in the above explanation. For A E, 3d figure above, which marks the direction of the violet rays in the outer bow, contains with AX, the axis of vision, a greater angle than A D, (which marks the direction of the red rays,) contains with the same axis. And the reverse is the case in the interior bow. It is evident, (for a reason similar to that given in the case of the interior bow) that an exterior bow cannot be seen when the elevation of the sun is above 54° 7′.

*Lunar* RAINBOW. An iris formed by the refraction of the moon's rays, in drops of rain, in the night-time.

*Marine* RAINBOW, the *Sea Bow*, is a phenomenon sometimes observed in a much agitated sea, when winds, sweeping part of the tops of the waves, carry them aloft, so that the rays of the sun are refracted, &c. as in a common shower.

RAINGAGE, or PLUVIOMETER, a machine for measuring the quantity of rain that falls. There are various kinds of raingages; that used at the apartments belonging to the Royal Society at Somerset-house, is thus described:—The vessel that receives the rain is of a conical form, strengthened at the top by a brass ring twelve inches in diameter. The sides of the funnel and inner lip of the brass ring are inclined to the horizon in an angle of more than 65°, and the outer lip in an angle of more than 50°, which are such degrees of steepness, that there seems no probability either that any rain which falls within the funnel, or on the inner lip of the ring, shall dash out, or that which falls on the outer lip shall dash into the funnel. The annexed figure represents a raingage of the best construction. It consists of a hollow cylinder, having within it a cork ball attached to a wooden stem, which passes through a small opening at the top, on which is placed a large funnel. When this instrument is placed in the open air in a free place, the rain that falls within the circumference of the funnel will run down into a tube, and cause the cork to float; and the quantity of water in the tube may be seen by the height to which the stem of the float is raised. The stem of the float is so graduated as to shew, by its divisions, the number of perpendicular inches of water which fell on the surface of the earth since the last observation. It is hardly necessary to observe, that after every observation the cylinder must be emptied.



A very simple raingage, and one which answers all practical purposes, consists of a copper funnel, the area of whose opening is exactly ten square inches; this funnel is fixed in a bottle, and the quantity of rain caught is ascertained by multiplying the weight in ounces by 173, which gives the depth in inches and parts of an inch. In fixing these gages, care must be taken that the rain may have free access to them; hence, the tops of buildings are usually the best places. When quantities of rain collected in them at different places are compared, the instruments ought to be fixed at the same heights above the ground at both places, because, at different heights, the quantities are always different, even at the same place. *See* RAIN.

RAISING *a Purchase*, the act of disposing certain instruments or machines, in such a manner as that, by their mutual effects, they may produce a mechanical force sufficient to overcome the weight or resistance of the object to which this machinery is applied.

RAISINS, grapes prepared by suffering them to remain on the vine till they are perfectly ripe, and then drying them in the sun, or by the heat of an oven. The difference between raisins dried in the sun, and those dried in ovens, is very obvious: the former are sweet and pleasant; but the latter have a latent acidity with the sweetness, that renders them much less agreeable.

RAIT, in Rural Economy, a term used to signify the process or operation of dissipating the sap of vegetables by exposure to moisture, or the influence of the atmosphere. It is sometimes applied to hay when it has been much exposed to the alternations of wet and dry weather, but more particularly to hemp and flax. The process of raiting requires much nicety, its design being to detach the covering or bark of hemp and flax from the stalk, by spreading the plants thinly upon close grassy surfaces, or putting them into water during a given time for the same purpose.

RAKE, in Agriculture, a tool of the tooth kind, made use of for many purposes of husbandry, as for collecting together hay, corn, stubble, roots, leaves, and other similar materials. Of this implement there are many descriptions.

RAKE, the projection of the upper parts of a ship at the height of the stem and stern, beyond the extremities of the keel; thus, if a plummet is hung from the top of a ship's stern, so as to be level with the continuation of the keel, the distance between the after-end of the keel and the plummet will be the length of the rake of the stern.

RAKE, is also applied to the masts when they are out of a perpendicular situation, as, that ship's mainmast rakes aft.

RAKING, the act of cannonading a ship on the stern or head, so as that the balls shall range the whole length of the decks, which is one of the most dangerous incidents that can happen in a naval action; this is frequently called raking fore and aft, and is similar to what is termed by engineers enfilading.

RAKE, or *Vein*, in Geology, is the most common repository of metallic ores. These veins intersect mountains sometimes nearly in a vertical manner, but more generally with a greater or less degree of inclination from a perpendicular.

RALLYING, in War, re-assembling or calling together troops broken and put to flight.

RAM, in Hydraulics, is a machine for raising water to any given height, by means of the momentum of a stream of water flowing through a pipe. The passage of the pipe being stopped by a valve, which is raised by the stream as soon as its motion becomes sufficiently rapid, the whole column of water concentrates on the valve, and acts as a single solid, so that it must resist any pressure. Now if the valve open into a pipe leading to an air vessel, a certain quantity of water will be forced into it, so as to condense the air more or less rapidly, to the degree that may be required for raising a portion of the water contained in it to any given height.

RAM, in Mythology, the name of the highest god among the Gentoos.

RAM, *Battering*, in Artillery, is a military engine with an iron head, resembling that of a ram, much used by the ancients to batter and break down the walls of places besieged; but since the invention of cannon, this once formidable instrument has been dismissed from service. Battering rams were of three kinds; the first rude and plain, the others artificial and compound. The first appears to have been nothing more than a huge beam headed with iron, with which men by mere muscular force assailed a wall, and yet produced but little effect. Josephus describes a second sort of battering ran, as resembling the mast of a ship suspended horizontally in the middle by ropes fastened to another beam above, which is fixed on posts for its support. Thus balanced, it is swung by a number of men, in proportion to its weight, with its head violently against the wall, from which it recoils, and becomes prepared for another stroke. Scarcely any building could resist the tremendous blows of this machine. The third sort differed from the second only by having covering for the soldiers, to guard them against missiles thrown from the walls. Some of these destructive instruments were suspended in a frame mounted on wheels for their more easy conveyance from place to place; and we are informed by Plutarch and Vitruvius, that they varied in length from 80 to upwards of one hundred feet; and while from the effects the largest have been known to produce, modern calculators have estimated their weight at more that three hundred tons. So late as the fourteenth century the ram was much in use. It was employed by Sir Christopher Wren in demolishing the walls of the old church of St Paul's, in order to his erecting the present structure, and was found to be an excellent machine for the completion of his purpose. *See* BATTERING *Ram.*

RAMA, in Hindoo Mythology, the name of a celebrated mortal, in whom their deity Vishnoo was incarnated for the purpose of relieving mankind from the oppression of Ravena, the malignant king of Lanka or Ceylon.

RAMADAN, a sort of lent observed among the Mahometans with great rigour, during which they fast the whole day from the first appearance of a new moon until the next new moon appears. To make amends for this abstinence, their nights are spent in riot and dissipation.

RAMAYANA, the title of a poem in Sanscrit, of great celebrity in India, regarded as sacred by some sects, and greatly venerated by all.*

RAMI, in Hindoo Mythology, one of the many names of the goddess Parvati.

RAMMER, is a cylindrical block of wood nearly fitting the bore of a cannon, and fastened on a wooden staff, or on a stiff rope well served with spun yarn. It is used to drive the charge of a cannon home, or to the innermost part of it. The rope-rammers are most general in ships of war.

RAMPART, in Fortification, a massy bank or elevation of earth raised above the body of a place, to shelter those within from the direct fire of the enemy.

RAMPHASTOS, the *Toucan*, &c. a genus belonging to the order of picæ. The bill is very large, and serrated outwardly. The nostrils are situated behind the base of the beak; and in most of the species the feet are toed, and placed two forwards and two backwards. The tongue is long, narrow, and feathered on the edges. Mr. Latham enumerates 15 different species.

RAMPHOID, a particular point of retrogression.

RAMSDEN'S MACHINE *for dividing Mathematical Instruments*, is a useful invention, by which these divisions can be performed with exceedingly great accuracy, such as would formerly have been deemed incredible. On discovering the method of constructing this machine, its inventor, Mr. Jesse Ramsden, received £615 from the commissioners of longitude; engaging himself to instruct a certain number of persons, not exceeding ten, in the method of making and using this machine from the 28th of October, 1775, to 28th of October, 1777; also binding himself to divide all octants and sextants by the same engine, at the rate of three shillings for each octant, and six shilings for each brass sextant, with Nonius's divisions to half-minutes, for as long time as the commissioners should think proper to let the engine remain in his possession. Of this sum of £615 paid to Mr. Ramsden, £300 were given him as a reward for the improvement made by him in discovering the engine, and the remaining £315, for his giving up the property of it to the commissioners.

This engine consists of a large wheel of bell metal, supported on a mahogany stand, having three legs, which are strongly connected together by braces, so as to make it perfectly steady. On each leg of the stand is placed a conical friction-pulley, whereon the dividing wheel rests: to prevent the wheel from sliding off the friction pulleys, the bell metal centre under it turns in a socket on the top of the stand. The circumference of the wheel is ratched or cut into 2160 teeth, in which an endless screw acts. Six revolutions of the screw will move the wheel a space equal to one degree. Now, a circle of brass being fixed on the screw arbor, having its circumference divided into 60 parts, each division will, consequently, answer to a motion of the wheel of 10 seconds, six of them will be equal to a minute, &c. Several different arbors of tempered steel are truly ground into the socket in the centre of the wheel. The upper parts of the arbors that stand upon the plane are turned of various sizes, to suit the centres of different pieces of work to be divided. When any instrument is to be divided, the centre of it is very exactly fitted on one of these arbors; and the instrument is fixed down to the plane of the dividing wheel, by means of screws, which fit into the holes made in the radii of the wheel for that purpose. The instrument being thus fitted on the plane of the wheel, the frame which carries the dividing point is connected at one end by finger screws, with the frame which carries the endless screw; while the other end embraces that part of the steel arbor which stands above the instrument to be divided, by an angular notch, in a piece of hardened steel; by this means both ends of the frame are kept perfectly steady, and free from any shake. The frame carrying the dividing point or tracer, is made to slide on the frame which carries the endless screw to any distance from the centre of the wheel, as the radius of the instrument to be divided may require, and may be there fastened by tightening two clumps; and the dividing point or tracer being connected with the clumps by the double-jointed frame, admits a free and easy motion towards, or from, the centre for cutting the divisions, without any lateral shake. From what has been said, it appears, that an instrument thus fitted on the dividing wheel, may be moved to any angle by the screw and divided circle on its arbor, and that this angle may be marked on the limb of the instrument with the greatest exactness by the dividing point or tracer, which can only move in a direct line tending to the centre, and is altogether freed from those inconveniences that attend cutting by means of a straight edge. This method of drawing lines will also prevent any error that might arise from an expansion or contraction of the metal during the time of dividing.

RAMUS, PETER, a celebrated French mathematician and philosopher, was born in 1515, and fell a sacrifice to his religious opinion, on the massacre of St. Bartholomew's day, 1572, in his 57th year. He was author of several works relating to mathematical subjects.

RAN, twenty cords of twine wound on a reel, every cord so parted by a knot as to be easily separated.

RANA, the *Frog*, in Natural History, a genus of Amphibia of the order of Reptiles. There are thirty-six species, of which the following deserve the chief attention:—The common toad, is found in shady and damp situations throughout Europe, and often is met with in cellars. In spring it moves towards the water, and lays its ova in a brilliant band of glutinous substance, several feet in length. The ova appear like beads of jet, and in fourteen days these convolved larvæ are developed and swim about, nourishing themselves by insects and vegetable substances, till their tail disappears, and their legs are formed, and they pass from water to land. The toad is always covered with tubercles, is generally of a dark brown colour above, and a light yellow on the lower parts both of the body and limbs. It lives to a considerable age, surviving in many instances even twenty years; and the case of a toad, which arrived at the age of forty, is mentioned by Mr. Pennant. The ideas formerly entertained of venomous qualities possessed by this animal, are now ascertained to be well founded, as Sir H. Davy has found, on dissection and analysis, venomous matter contained in follicles in the *cutis vera*, round the head, and even on the extremities.—Statements have often been published of toads found living in large blocks of wood and of stone, with no perceivable inlet for the air, and touched on all sides by the substance in which they were enclosed. It is ascertained that a toad will live for many weeks, and even months, in a very small case, or under a pan, buried deeply in the earth. The eyes of the toad are remarkable for their clearness and beauty, and excite sensations of a very different nature from that disgust, and even horror, which its general appearance almost universally excites. The Surinam toad, much larger than the common toad, being sometimes seven inches in length, is almost equally loathsome with the last, and is distinguished particularly by that curious deviation from the general course of nature, the exclusion of its young from its back, which contains a variety of cells for their residence, and a certain degree of maturation. The common frog, is met with almost every where throughout Europe, in low and wet situations, where it can procure that food on which it principally subsists, worms and insects. The green frog, is much larger than the last species, and abounds in many countries in Europe, though but rarely to be found in England. They are in some places much used for food, particularly in France, and thought fittest for the table in the month of June. The bull-frog, is found in many regions of North America, and grows to the length of eighteen inches from the nose to the hind feet. Its sounds resemble the lowing of a bull. They are highly rapacious, often commit great depredations on the poultry, swallowing even young geese without considerable difficulty. The tree frog, is not found in Great Britain, but is met with in various other parts of Europe, and in elegance and activity is superior to every other European species. In summer it resides in the woods, and haunts the trees in quest of insects, which it approaches on its belly, in the same manner as a cat to a mouse, and at length seizes with an elastic and instantaneous spring. It is particularly noisy on the approach of rain. In winter it takes up its abode in the bottom of the waters, remaining till the spring in a state of torpor.

RANCIDITY, in Chemistery. Fixed oils are liable, by keeping, to undergo a change well known by the name of rancidity. They become thick, acquire a brown colour, an acrid taste, and a disagreeable smell. The oil thus altered converts vegetable blues into red, and of course contains acid.

RANDOM SHOT, in Gunnery, is a shot made when the muzzle of a gun is raised above the horizontal line, and is not designed to shoot directly or point-blank. The utmost random of any piece is about ten times as far as the bullet will go point-blank.

RANELAGH *Rotunda* and *Gardens*, near Chelsea, built and opened for musical performances in 1742. Degenerating into a scene of licentiousness, it was shut up in 1803, since which the buildings have been wholly demolished.

RANGE, in Gunnery, the path of a bullet, or the line it describes from the mouth of the piece to the point where it lodges.

RANGE, a sufficient length of the cable drawn upon the deck before the anchor is let go, that, by its sinking to the bottom without being interrupted, the flukes may be forced deeper into the ground; therefore the range drawn up out of the tier ought to be equal in length to the depth of the water where the ship anchors.

RANGE, is also the distance to which a bomb or cannon ball is thrown from a piece of artillery by the explosion of gunpowder. The flight of a shot is distinguished by artillery men into two different ranges, of which the first is called the point-blank, and the second the random shot; to these also may be added the ricochet, or rolling and bounding shot. The point-blank range is the extent of the apparent right line described by a ball discharged from a cannon. The random shot is, when, by letting the breach down upon the bed of the carriage, the ball is carried to its greatest possible distance, and describes a curve in its flight. The ricochet is fired by elevating the piece from three to six degrees, and only charging it with a quantity of powder sufficient to carry the shot along the face of the works attacked; the shot, thus discharged, so as to go just over the parapet, rolls, and bounds about, killing, maiming, or destroying all it meets in its course, creating much more disorder by going thus slowly, than if thrown from the piece with greater violence. As one of the effects of the bomb results from its weight, the range of mortars is extremely different from that of cannon, because the former is not pointed at a certain object like the latter, but inclined to the horizon at a certain angle, so that the bomb being thrown up obliquely, may fall upon the place intended; hence it appears, that the mortar has no point-blank range, or at least that no use is made of it. To make a bomb fall on a given place, two things are to be considered, *viz.* the elevation of the mortar, and the quantity of powder used to charge it: respecting the former, a bomb will be thrown to the greatest distance when the elevation of the mortar is 45 degrees, it being the half of 90 degrees, or a right angle, that is equally distant from the horizon and the zenith; hence it follows, that if a mortar is elevated any number of degrees above 45, it will throw the shell to the same distance as if depressed an equal number of degrees below 45: where weight is required, as for the destruction of any building, the mortar should be elevated as much as possible for the distance, but when the business is to fire on a body of men, it must be pointed as much below 45, that the bomb may not have force to penetrate far into the ground, and the splinters in the explosion may do more execution. Ricochet signifies duck and drake, a name given to the bounding of a flat stone thrown almost horizontally into the water.

It was the opinion of engineers formerly, that by charging the pieces high, the ball was thrown to a greater distance. Hence the pieces were charged with two-thirds, or even the whole weight of the shot, in order to impel it with greater velocity; but it has been discovered since, that the half or one-third of the weight of the ball is the fittest charge for the piece. It may not be amiss to observe here, that the range of cannon is greater in the morning and at night, than at noon; and in cold, than in hot weather. The reason is, that at these times the air being less heated, gives less way to the dilatation of the powder, which being, by these means, confined as it were to a smaller sphere of action, must have a stronger effect in proportion. When the lengths of cannon are proportionable to the height of the charge, the shot will be discharged with the same velocity, whatever the calibre may be. The greatest distance to which a shell can be thrown, with the strongest charge, is little more than about 1800 or 2000 fathoms. *See* GUNNERY.

*To* RANGE, is to sail in a parallel direction, and near to, as, "we ranged the coast;" "the enemy came ranging up along side of us."

RANGER, a sworn officer of a forest, appointed by the king's letters patent, whose business is to walk through his charge, to drive back the deer out of the purlieus, &c. and to present all trespasses within his jurisdiction at the next forest court.

RANGES, in a ship, two pieces of timber that go across from side to side: the one on the forecastle, a little abaft the foremast; and the other in the beakhead, before the wouldings of the bowsprit.

RANK, in War, is a row of solders placed side by side.

RANK, the order or place assigned a person suitable to his quality or merit.

RANSOM, a sum of money paid for the redemption of a person out of slavery, or for the liberty of a prisoner of war.

RANT, an extraordinary flight of passion, overshooting nature and probability. It is sometimes introduced into the drama, and occasionally into the pulpit.

RANUNCULUS, a genus of the polyandria class, and polyginia order; in the natural method ranking in the 26th order, multisiliquæ. A well-known garden flower, of which there are many species. The Persian Crowfoot, or Garden Ranunculus, is the most noted.

RAPE, in Law, is where a man has carnal knowledge of a woman by force, and against her will; by 18 Eliz. c. 7, if any person shall unlawfully and carnally know and abuse any woman-child under the age of ten years, whether with her consent or against it, he shall be punished as for a rape. And it is not a sufficient excuse in the ravisher, to prove that she is a common strumpet; for she is still under the protection of the law, and may not be forced. Nor is the offence of a rape mitigated by shewing that the woman at last yielded to the violence, if such her consent was forced by fear of death or duress; nor is it any excuse that she consented after the fact, 1 Haw. 108.

RAPE, is also a name given to a division of a county, and sometimes means the same as a hundred, and at other times signifies a division consisting of several hundreds.

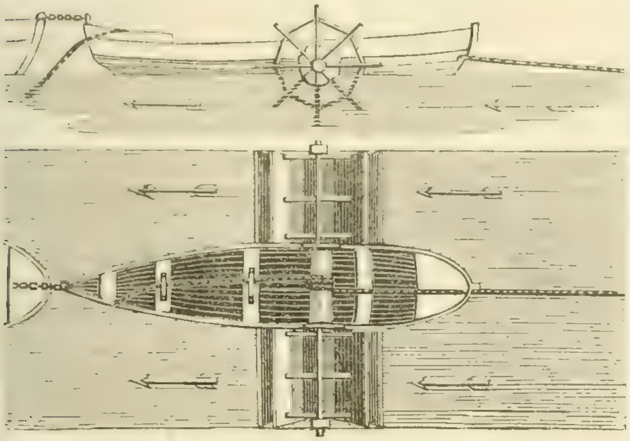
RAPE, in Gardening, the common name of a plant of the cabbage kind.

RAPE, in Agriculture the name of a plant much cultivated for its seed, and also as a green food for cattle and sheep.

RAPE *Oil*, an oil obtained by means of expression from the seeds of the above plant, in mills constructed for the purpose. The refuse is valuable as manure.

RAPHANUS, *Radish*, a genus of the siliquosa order, in the tetradynamia class of plants; and in the natural method ranking under the 39th order, siliquosæ. The calyx is close: the siliqua torose, or swelling out in knots, sub-articulated, and round. There are two melliferous glandules between the shorter stamina and the pistil, and two between the longer stamina and the calyx. There are six species.

**RAPIDS**, *Boat for passing up.* The American papers contain some remarkable accounts of a newly invented boat, which has been brought into operation on the rapids of the Delaware, which ascends against the stream, and tows up ordinary boats, heavily laden, with it. The plan seems to be this:—The anchor is dropped at the head of the rapid to be passed, to which is connected a rope, extending to the termination of the rapid; here a boat is provided, crossed by a shaft, to which is attached wheels with floats or paddles, of a width in proportion to the power required; on this shaft is a windlass, or drum, around which the rope is passed, and thence, over the stern of the boat, into the water; thus arranged, the boat is pushed into the rapid; and the current, acting with all its strength upon the floats, and they presenting to the stream a much greater surface and resistance or hold for the water than the prow of the boat, the wheels are turned by the current, which, winding up the rope, draws the boat irresistibly to the anchor at the head of the rapid. The boat has been found to ascend one-half faster than the current flows down, and to be capable of towing up whatever may offer itself.



The boat, having thus performed its voyage, its appendages are disengaged, it is dropt down with the current, and is then ready again for another trip up the rapid. A correspondent of the *New York Evening Post* says:—"I had the pleasure a few weeks since, of witnessing the first experiment of the boat at that place, (opposite Trenton on the Delaware,) and was much surprised that an invention of such great utility had not before been put in operation. There can be no doubt as to the practicability of the plan, and the competency of the power to be acquired for propelling heavy laden boats against rapids; for in the experiment I witnessed, there was towed up at the same time, *a large Durham boat, two batteaux, and twelve persons!* The Durham boat was old and leaky, and drew as much water as if loaded with three or four tons; and she ascended the rapids, (which run at about the rate of ten knots,) with as great rapidity apparently as when without any encumbrance. Many of our valuable rivers have not heretofore been navigated on account of obstructions in them by rapids, which have been insurmountable; but by the invention of Col. Clarke, such difficulties no longer exist. Much credit is certainly due to him for the invention, as it promises to be of the greatest utility to this country in the navigation of our rivers; and it is presumed that his plan will ere long be brought into general use throughout the United States."

**RAPIER**, formerly meant an old-fashioned cutting sword, but in the more modern sense it signifies a small sword, as contradistinguished from a cutting sword.

**RAPINE**, in Law. To take a thing in private against the owner's will is theft; but to take it openly, or by violence, is rapine or robbery.

**RAPIRTRUM**, in Botany, the wild turnip, so called from its affinity to Rapa, the cultivated one. It sometimes signifies a species of the sea cabbage.

**RAPTURE**, an ecstasy or transport of mind.

**RAPUNCULUS**, in Botany, a root formerly much cultivated, but at present very little known. Its name is derived from the resemblance which the root bears to an oblong turnip.

**RARA AVIS**, in Ornithology, the name of a bird common about the lakes and rivers of America. It is of the kingfisher kind, but nearly as large as a duck, black on the crown, but white on the breast and belly.

**RARE**, in Physics, a relative term, the reverse of dense, being used to denote a considerable porosity, or vacuity between the particles of a body; as the word dense implies a contiguity or closeness of the particles.

**RAREFACTION**, in Physics, is the making a body to expand, or occupy more room or space, without the accession of new matter. It is by rarefaction that gunpowder takes effect; and to the same principle also we owe eolipiles, thermometers, &c. The degree to which air is rarefiable, exceeds all imagination; perhaps, indeed, its degree of expansion is absolutely beyond all comprehensible limits. Upon the rarefaction of the air is founded the method of measuring altitudes by the baroter; in all cases of which, the rarity of the air is found to be inversely as the force that compresses it, or inversely as the weight of all the air above it at any place.

The open air, in which we breathe, says Sir Isaac Newton, is 8 or 900 times lighter than water, and by consequence 8 or 900 times rarer. And since the air is compressed by the weight of the incumbent atmosphere, and the density of the air is proportionable to the compressing force, it follows, by computation, that at the height of about seven English miles from the earth, the air is four times rarer than at the surface of the earth; and at the height of 21, 28, or 35 miles, it is respectively 64,256, or 1024 times rarer, or thereabouts; and at the height of 70, or 140, and 210 miles, it is about 1,000,000,-1,000,000,000,000, or 1,000,000,000,000,000,000, &c.

Mr. Cotes has found, from experiments made with a thermometer, that linseed oil is rarefied in the proportion of 40 to 39 with the heat of the human body; in that of to 15 to 14, with that degree of heat wherein water is made to boil; in the proportion of 15 to 13 in that degree of heat wherein melted tin begins to harden; and finally, in the proportion of 23 to 20, in that degree wherein melted tin arrives at a perfect solidity. The same author discovered, that the rarefaction of the air, in the same degree of heat, is ten times greater than that of linseed oil; and the rarefaction of the oil about fifteen times greater than that of the spirit of wine.

**RARITY**, lightness, thinness, the reverse of density.

**RAT**. *See* MUS.

*A Simple* RAT *Trap.*—Let a cask, ingeniously placed, be half filled with water, and let a false top, or lid, be nicely balanced about two inches below the edge of the mouth; in the middle of the lid let some wholesome meat be fastened, (as rats are very nice,) so that, the moment one of them sets foot upon the edge, it may be precipitated into the water below; and, as the lid immediately resumes its position, the victim is secured, and a second, a third, or a fourth, may be successively secured and destroyed.

**RATAFIA**, a spirituous liquor, prepared from the kernels, &c. of several kinds of fruit, particularly of cherries and apricots. Ratafia of cherries is prepared by bruising the cherries, and putting them into a vessel wherein brandy has long been kept; then adding to them the kernels of cherries, with strawberries, sugar, cinnamon, white pepper, nutmegs, cloves; and to twenty pounds of cherries, ten quarts of brandy. The vessel is left open ten or twelve days, and then stopped close for two months before it is tapped. Ratafia of apricots is prepared two ways, *viz.* either by boiling the apricots in white wine, adding to the liquor an equal quantity of brandy with sugar, cinnamon, mace, and the kernels of apricots; infusing the whole for eight or ten days, then straining the liquor, and putting it up for use: or else by infusing the apricots cut in pieces in brandy, for a day or two, passing it through a straining bag, and then putting in the usual ingredients.

**RATCH**, or RASH, in Clock-work, a sort of wheel having twelve fangs, which serves to lift up the detents every hour, and make the clock strike.

**RATCHETS**, in a watch, are the small teeth at the bottom of the fusee, or barrel, which stops it in winding up.

**RATE**, the order or classes into which the ships of war are divided in the navy, according to their force and magnitude; thus, the

*First Rate*, comprehends all ships of one hundred guns and upwards, having 42 pounders on the lower deck, 24 ditto on the middle deck, 12 ditto on the upper deck, and 6 ditto on the quarter deck and forecastle. They are manned with 850 to 875 men, including their officers, seamen, marines, servants, &c.—N. B. In general the ships of every rate besides the captain, have the master, the boatswain, the gunner, the chaplain, the purser, the surgeon, and the carpenter; all of whom except the chaplain have their mates or assistants, in which are comprehended the sail-maker, the master at arms, the armourer, the captain's clerk, the gunsmith, &c. The number of other officers are always in proportion to the rate of the ship. A first rate has 6 lieutenants, 6 master's mates, 24 midshipmen, and 5 surgeon's mates, who are considered as gentlemen; besides the following petty officers, quarter-masters and their mates, 14; boatswain's-mates, and yeomen, 8; gunner's mates and assistants, 6: quarter-gunners, 25; carpenter's-mates, 2, besides 14 assistants; 1 steward's-mate to the purser, &c.

*Second Rate*, includes all ships carrying from 90 to 98 guns upon three decks, of which those on the lower battery are 32 pounders; and those on the middle 18 ditto; on the upper deck 12 ditto, and those on the quarter-deck 6 ditto; which usually mount to 4 and 6; their complement of men is from 700 to 750, in which are 6 lieutenants, 4 master's-mates, 24 midshipmen, and 4 surgeon's mates; 14 quarter masters, and their mates, 8 boatswain's mates and yeomen; with 22 quarter gunners, 2 carpenter's-mates, with 10 assistants, and 1 steward, and 1 steward's mate.

*Third Rate*, consists of ships from 64 to 80 cannon, which are 32, 18, and 9 pounders. The 80 gun-ships, however, begin to grow out of repute, and give way to those of 74, 70, &c. which have only two whole batteries, whereas the former have three, with 28 guns planted on each, the cannon of their upper deck being the same as those on the quarter deck and forecastle of the latter, which are 9 pounders. The complement in a 74 is 650, and in a 64, 500 men; having in peace 4 lieutenants; but in war, 5; and when an admiral is aboard, 6. They have 3 master's-mates, 16 midshipmen, 3 surgeon's-mates, 10 quarter-masters and their mates, 6 boatswain's mates and yeomen, 4 gunner's mates and yeomen, with 18 quarter gunners, 1 carpenter's mate, with 8 assistants, and 1 steward and steward's mate under the purser.

*Fourth Rates*, consist of ships from 50 to 60 guns upon two decks and the quarter-deck. The lower tier is composed of 24 pounders, and the upper tier of 12 ditto, and the quarter deck and forecastle 6 ditto. The complement of a 50-gun ship is 350 men in which there are 3 lieutenants, 2 master's-mates, 10 midshipmen, 2 surgeon's-mates, 6 quarter-masters and their mates, 4 boatswain's mates and yeomen, 1 gunner, and 1 yeoman, with 12 quarter-gunners, 1 capenter's mate, and 6 assistants, and a steward and steward's mate.

All vessels of war under the fourth rate are usually comprehended under the general names of frigates, and never appear in the line of battle. They are divided into two rates, *viz.*

*Fifth Rates*, mounting from 32 to 40 or 44 guns. The latter have two decks of cannon, the lower battery being of 18 pounders, and that of the upper deck 6 ditto; but those of 36, or 32 guns, have only one complete deck of guns, mounting 12 pounders, besides the quarter-deck and forecastle, which carry 6 ditto. The complement of 44 guns is 280 men, and that of a frigate of 36 guns 240 men. The first has 3, and the second 2 lieutenants, and both have 2 master's mates, 6 midshipmen, 2 surgeon's mates, 6 quarter masters and their mates, 2 boatswain's-mates and 1 yeoman, 1 gunner's-mate and 1 yeoman, with 10 or 11 quarter gunners, and 1 purser's steward.

*Sixth Rates*, consist of frigates from 20 to 30 guns, and carry 9 pounders; those of 28 guns having 3 pounders on their quarter deck, with 200 men for their complement; and those of 24, 160 men. The former has 2 lieutenants, the latter 1, and both have two master's-mates, 4 midshipmen, 1 surgeon's-mate, 4 quarter masters and their mates, 1 boatswain's mate and 1 yeoman, 1 gunner's mate and 1 yeoman, with 6 or 7 quarter gunners, and 1 purser's-steward. The whole of these rates are termed post ships, *i. e.* their commander is a post captain, while those captains commanding vessels are denominated MASTERS and COMMANDERS; which see. This last rate is generally said to comprehend all brigs, sloops of war, cutters, schooners, &c. carrying from 6 to 18 guns, but it is only true with respect to their pay, the rest of their establisment of officers and crew varying according to their force and magnitude, many of them being commanded by lieutenants, and some, such as gun-boats, &c. by midshipmen, who have passed for lieutenants. The sloops of war carry from 8 to 18 cannon, the latter having 6 pounders, and the former (those from 8 to 10 guns) 4 pounders. Their officers are generally the same as in the sixth rates, with little variation, and their complement of men are from 120 to 60, in proportion to their force or magnitude.—N. B. Bomb-vessels are on the same establishment as sloops; but fire-ships and hospital-ships are on that of fifth rates.

**RATEEN**, in Commerce, a thick woollen stuff, quilled, woven on a loom with four treadles, like serges, and other stuffs, that have the whale or quilling.

**RATIO**, is the relation of two quantities of the same kind with respect to quantity, and is by some authors divided into arithmetical and geometrical ratio; *viz.* arithmetical, when the term is used with respect to the difference of the two quantities; and geometrical, when it relates to the number of times in which the one of those quantities is contained in the other; thus the ratio of 6 to 3 is $\frac{6}{3} = 2$. The leading term of the ratio being called the *antecedent*, and the latter the *consequent*; also the quotient or division of the former by the latter, is called the index or *exponent* of the ratio. The equality of ratios constitute proportion. *See* PROPORTION.

RATIO, is also distinguished by some authors, (principally of the old school,) into a variety of denominations, many of which are totally useless; but which cannot, notwithstanding, be passed over in the present article.

*Irrational* RATIO, is, when one of the terms of the ratio, at least, is an irrational quantity; such is the ratio of $\surd 3$ to 1.

*Rational* RATIO, is when there is no irrational quantity enters, or when the same irrational quantity enters into both terms, thus $\surd 6$ to $\surd 24 = \surd 6$ to $2 \surd 6 = 1$ to 2.

RATIO of *Equality*, is when the terms expressing the ratio are equal, and therefore the exponent $= 1$.

RATIO of *Greater Inequality*, is when the antecedent exceeds the consequent; and *ratio of less inequality*, is when the latter exceeds the former.

For several other distinctions, as *Compound*, *Duplicate*, *Subduplicate*, *Triplicate*, *Subtriplicate*, &c. see the several articles.

*Reduction* of RATIOS, is the reducing them to less terms, the ratio of 36 to $24 = 6$ to $4 = 3$ to 2. Sometimes, however, when the terms of the ratio are very large it is difficult to reduce them in this manner, and then recourse must be had to the method of finding the greatest common measure or common divisor, which also fails if the two terms are prime to each other. In this case, though the exact ratio cannot be found in less terms, it is frequently desirable to find an approximate ratio expressed in less terms, and recourse must then be had to continued fractions, *viz.* convert the given ratio into a continued fraction, and thence find the series of converging fractions, each of which will be an approximate ratio of the proposed one, and so much the more accurate as it is farther advanced in the series. Let 1103 to 887 be a ratio, to which it is required to find an approximate ratio in less terms.

887 ) 1103 ( 1
216 ) 887 ( 4
23 ) 216 ( 9
9 ) 23 ( 2
5 ) 9 ( 1
4 ) 5 ( 1
1 ) 4 ( 4

Hence by the rule in continued fractions,

quoto. 1 4 9 2 1 1 4

app. ratios $\frac{1}{1}, \frac{5}{4}, \frac{46}{37}, \frac{97}{78}, \frac{143}{115}, \frac{240}{193}, \frac{1103}{887}$.

Each of which fractions approximates nearer to the true ratio than any of those which precede it, and each nearer than any ratio that can be expressed in less terms.

**RATIOCINATION**, the act of reasoning.

**RATION**, in the Army, a portion of ammunition, bread, drink, and forage, distributed to each soldier in the army, for his daily subsistence, &c. The horse have rations of hay and oats when they cannot go out to forage. The rations of bread are regulated by weight. The ordinary ration of a foot soldier is a pound and a half of bread per day. The officers have several rations according to their quality and the number of attendants they are obliged to keep. When the ration is augmented on occasions of rejoicing, it is called a double ration.

In the navy the rations of every man are a pound of bread and meat per day, a pint of chocolate for breakfast, half a pint of rum, which is mixed with water before it is served out; together with salt, vinegar, and vegetables.

**RATIONABILES EXPENSÆ**, reasonable expenses, paid to members of parliament, and the proctors of the clergy in convocation, by the people, determined by the king, the prices of the necessary articles being taken into a due consideration.

**RATIONABILI PARTE BONORUM**, a writ which lies for the wife against the executors of her husband, if they refuse her the third part of her effects, all debts being paid.

**RATIONAL FRACTIONS**, is the term commonly used to express those fractions which may be decomposed into other fractions, the sum of which is equal to the given fraction; this cannot in all cases be effected, but where it can, such fractions are called rational fractions. In simple numerical fractions, the decomposition, when it can be effected, is drawn from the indeterminate analysis. Thus, let it be proposed to resolve the fraction $\frac{19}{35}$ into two other fractions. Since $35 = 7 \cdot 5$, let the two required fractions be $\frac{x}{7}$ and $\frac{y}{5}$; then their sum $\frac{5x+7y}{35} = \frac{19}{35}$; whence $5x + 7y = 19$, which is an indeterminate equation of the first degree, and the solution of it gives $x = 1$ and $y = 2$; therefore $\frac{19}{35} = \frac{1}{7} + \frac{2}{5}$.

If the denominator is a prime number, the decomposition is impossible, as it is also in some other cases; but if $x$ and $y$ are prime factors of the denominator, and the numerator is greater than $xy - x - y$, then the decomposition is always possible.

If the denominator consists of three or more prime factors, then making it equal to $\frac{a}{x} + \frac{b}{y} + \frac{c}{z} +$ &c. the decomposition may still be effected by means of an indeterminate equation of the first degree. But the principal use of this decomposition is in the inverse method of fluxions, or the integral calculus, for which purpose they were first investigated by Leibnitz, and have been since much extended by the researches of Cotes, Euler, Simpson, Lagrange, &c.

**RATIONAL** *Quantities*, in Algebra, are those which are expressed without any radical signs, being equivalent to integers, or fractions, in arithmetic, which are called rational numbers, or quantities, in contradistinction to irrational or surd quantities. *See* SURDS.

**RATIONAL** *Horizon*. *See* HORIZON.

**RATIONALE**, a solution or account of the principles of some opinion, action, hypothesis, phenomenon, or the like.

**RATLINES**, small lines which traverse the shrouds of a ship horizontally at regular distances from the deck upwards, and forming a variety of ladders whereby to climb or to descend from any of the mast-heads.

*To rattle down the Shrouds*, is to fix the ratlines to them in order to prevent them from slipping down by the weight of the sailors; they are firmly attached by a knot called a clove hitch, to all the shrouds except the fore-most or aft-most.

**RAURAVA**, a Sancrit word meaning dreadful, and a name of one of the Hindoo hells. They reckon twenty-one of these receptacles for sinners, of which the Naraka is the most dreadful.

**RAVELIN**, in Fortification, was anciently a flat bastion, placed in the middle of a curtain; but now a detached work, composed only of two faces which make a saliant angle, without any flanks, and raised before the curtain on the counterscarp of the place. A ravelin is a triangular work, resembling the point of a bastion with the flanks cut off.

**RAVEN**. *See* CORVUS.

**RAVISHMENT**, in Law, denotes an unlawful seducing either a woman or an heiress in ward, for which there is a remedy by a writ of ravishment, or action of trespass, in the same manner as the husband may have it on account of the abduction of his wife.

**RAW**, in Agriculture, denotes any sort of plant, substance, or material, which is green, unripe, or in an undigested condition. Hence, raw land, raw cream, raw hide, raw silk, &c.

**RAY**, in Optics, a beam of light propagated from a radiant point. If the ray comes direct from the radiant point to the eye, it is said to be *direct*; if it first strike upon any body, and is hence transmitted to the eye, it is said to be *reflected*, and the ray itself is called a *reflected ray*; and if the ray in its passage to the eye be bent or turned out of its direct course by passing through any medium, it is said to be *refracted*, and is thence called a *refracted ray*. When two or more rays proceed in directions parallel to each other, they are called *parallel rays*. If they converge towards each other, they are called *converging rays*, and if they diverge, *diverging rays*; and those which pass directly to the eye in any case, are called *visual rays*. Among other qualities of rays it has been found, by experiment, that there is a very great difference in the heating power of the different rays from the sun.

It appears from the experiments of Dr Herschel, that the heating power increases from the middle of the spectrum to the red rays, and is greatest beyond it where the rays are invisible. Hence it is inferred, that the rays of light and caloric nearly accompany each other, and that the latter are in different proportions in the different coloured rays; these are easily separated from each other, as when the sun's rays are transmitted through a transparent body, the rays of light pass on seemingly undiminished, but the rays of caloric are intercepted. When the sun's rays are directed to an opaque body, the rays of light are reflected, and the rays of caloric are absorbed and retained. This is the case with the light of the moon, which, however much it be concentrated, gives no indication of being accompanied with heat. It has also been shewn, that the different rays of light produce different chemical effects on the metallic salts and oxides. These effects increase on the opposite direction of the spectrum, from the heating power of the rays. From the middle of the spectrum, towards the violet end, they become more powerful, and produce the greatest effect beyond the visible rays. From these discoveries it appears, that the solar rays are of three kinds. 1. Rays which produce heat. 2. Rays which produce colour; and 3. Rays which deprive metallic substances of their oxygen. The first set of rays is in greatest abundance, or are most powerful towards the red end of the spectrum, and are least refracted. The second set, or those which illuminate objects, are most powerful in the middle of the spectrum. And the third set produce the greatest effect towards the violet end, where the rays are most refracted. The solar rays pass through transparent bodies without increasing their temperature. The atmosphere, for instance, receives no increase of temperature, by transmitting the sun's rays, till these rays are reflected from other bodies or are communicated to it by bodies which have absorbed them. This is also proved by the sun's rays being transmitted through convex lenses, producing a higher degree of temperature when they are concentrated, but giving no increase of temperature to the glass itself. By this method, the heat which proceeds from the sun can be greatly increased. Indeed, the intensity of temperature produced in this way, is equal to that of the hottest furnace. This is done either by reflecting the sun's rays from a concave polished mirror, or by concentrating, or collecting them by the refractive power of convex lenses, and directing the rays thus concentrated on the combustible body. *See* BURNING *Glass*.

**RAY, or RYE GRASS**, in Agriculture, a valuable sort of early grass, that has been long, and still is much cultivated in some districts.

**RAZOR**, a well known keen edged instrument used in shaving. Heat appears to give a partial increase of tenacity to a razor's edge, but the reason has not been satisfactorily assigned.

**REACH**, in Sea Language, signifies the distance between any two points of land, lying nearly in a right line.

**REACTION**, in Physics, the action by which a body acted upon returns the action by a reciprocal one upon the agent.

**Reaction**, in Physiology, the resistance made by all bodies to the action or impulse of others, that endeavour to change their state whether of motion or rest.

**REAGENT.** In the experiments of chemical analysis, the component parts of bodies may either be ascertained in quantity as well as quality, by the perfect operations of the laboratory, or their quality alone may be detected by the operations of certain bodies called reagents. Thus the infusion of galls is a reagent, which detects iron by a dark purple precipitate; the prussiate of potash exhibits a blue, with the same metal, &c.

**REALGAR**, in Chemistry. Arsenic mineralized by sulphur forms two ores, named orpiment and realgar, the chemical distinction of which is not very accurately determined. That which has been named realgar is of a red colour, sometimes inclining to a scarlet, sometimes to orange. It occurs massive, disseminated, and crystallized, in oblique tetrahedral or hexhaedral prisms, generally small and translucent, or semitransparent, with a shining lustre. Its fracture is uneven; it is soft and brittle, and has a specific gravity of 3·2, or 3·3. It exhales before the blow-pipe with a white arsenical and sulphurous odour, and gives a blue flame. It consists of arsenic and sulphur in the proportions of 80 of the former, and 20 of the latter.

**REALISTS**, a sect of school philosophers, who followed the doctrine of Artistotle with respect to universal ideas, in opposition to the *Nominalists*, who embraced the hypotheses of Zeno and the Stoics.

**REAPING**, in Agriculture, the operation of cutting crops either of corn, pease, beans, flax, &c. by means of a sickle or a reaping-hook. Several attempts have been made to construct reaping machines, but they have not hitherto been crowned with much success.

**REAR**, a name given to the last division of a squadron, or the last squadron of a fleet, and which is accordingly commanded by a third officer of the said squadron or fleet.

**REASON**, a faculty or power of the soul, by which it distinguishes good from evil, truth from falsehood; or, on comparing several things together, by which we draw consequences from the relations they are found to have. Mr. Locke observes, that reason comprehends two distinct faculties of the mind, namely, *sagacity*, by which it finds intermediate ideas, and *illation*, by which it so orders and arranges them, as to discover what connexion there is in each link of the chain by which the extremes are held together. By these means it draws into view the truth which was sought. All our ideas are either *according* to reason, *above* its comprehension, or *contrary* to its dictates. The first *must* be true, the second *may be* true, but the third *cannot*, and on this account should be rejected. Reason, as contradistinguished from faith, is the discovery of the certainty or probability of such propositions as it has obtained by the use of its natural faculties. Faith, on the other hand, is the assent of the mind to any given proposition upon the credit of the proposer. Thus Revelation is received as coming immediately from God.

**REASONING**, the exercise of the faculty of the mind called reasoning; or it is an act or operation of the mind, deducing some unknown proposition from other previous ones that are evident and known.

**REAUMUR, Rene Antoine**, a celebrated French philosopher, was born at Rochelle, in 1683. He was author of several works, but none that requires any mention in this article. He invented the thermometer which bears his name, a description of which is given under that article. Reaumur died in 1757.

**REBATE**, or **Rebatement**, in Commerce, a term much used at Amsterdam, for an abatement in the price of several commodities, when the buyer, instead of taking time, advances ready money.

**REBELLION**, taking up arms traitorously against the king, be it by natural subjects, or by others once subdued.

**Rebellion**, originally signified, among the Romans, a rising of such persons or tribes as had been formerly overcome in battle, and had yielded themselves to their subjection. It is now generally understood as a traitorous taking up arms against the king, either by his natural subjects, or by communities that had been subdued. Much, however, depends on the issue; a successful revolt makes a revolution, an unsuccessful one is rebellion.

**REBUTTER**, is the answer of the defendant to the plaintiff's sur-rejoinder.

**RECAPITULATION**, in Oratory, &c. is a summary, or a concise and transient enumeration of the principal thing insisted on in the preceding discourse, whereby the force of the whole is collected into one view.

**RECAPTION.** Where one has deprived another of his property, the owner may lawfully claim and retake it wherever he happens to find it, so that it shall not be in a riotous manner, or attended with any breach of the peace.

**RECEIPTS**, are acknowledgments in writing of having received a sum of money or other value. A receipt is either a voucher for an obligation discharged or one incurred. Receipts for money above 40s. must be on stamps; but on the back of a bill of exchange or promissory note which is already stamped is good without a further duty. Writing a receipt on a stamp of greater value than the law requires, incurs no penalty, and the receipt is good; but if on a stamp of a lower value, or on unstamped paper, then a receipt is no discharge, and incurs a penalty.

**RECEIVER.** Receivers are chemical vessels which are adapted to the necks or beaks of retorts, alembics, and other distillatory vessels, to collect, receive, and contain the products of distillations.

**Receiver**, in Pneumatics, a glass vessel for containing the thing on which any experiment in the air-pump is to be made.

**RECESSION.** *See* Precession.

**RECIPE**, in Medicine, a prescription or remedy to be taken by a patient, so called because always beginning with the word recipe, i. e. take; which is generally denoted by the abbreviature R.

**RECIPIANGLE**, or **Recipient Angle**, a mathematical instrument, serving to measure re-entering and saliant angles especially in fortification.

**RECIPROCAL**, in Arithmetic and Algebra, is the quotient arising from dividing unity by any quantity; thus $1 \div \frac{x}{y} = \frac{y}{x}$ is the reciprocal of the fraction $\frac{x}{y}$.

**Reciprocal** *Equations*, are those which contain several pairs of roots, which are the reciprocal of each other.

**Reciprocal** *Figures*, in Geometry, are such as have the antecedent and consequents of the same ratio in both figures.

**Reciprocal** *Proportion*, is when the reciprocal of the two last terms have the same ratio as the quantities of the first terms, or when the antecedents are compared with the reciprocals of the consequents, thus, $5 : 8 :: 24 : 15$ is a reciprocal proportion, because $5 : 8 :: \frac{1}{24} : \frac{1}{15}$, or $5 : \frac{1}{24} :: 8 : \frac{1}{15}$.

**Reciprocal** *Ratio*, is the ratio of the reciprocals of two quantities.

**Reciprocal** *Terms*, among Logicians, are those which have the same signification; and consequently are convertible, or may be used for each other.

**RECIPROCALLY**, the property of being reciprocal; thus we say, that in bodies of the same weight, the density is reciprocally as the magnitude, *viz.* the greater the magnitude the less the density; and the less the magnitude, the greater the density. So again, the space being given, the velocity is reciprocally as the time.

**RECIPROCITY.** The law of reciprocity is a term employed by Legendre in his "Theory of Numbers," to denote a reciprocal law that has place between prime numbers of different forms, which is this, that $m$ and $n$ being prime odd numbers, the remainder of $m^{\frac{m-1}{2}}$ divided by $n =$ the remainder of $1^{\frac{m-1}{2}}$ divided by $m$; if $m$ and $n$ are not both of the form $4x - n$, and if they are both of this form, then the remainder of $m^{\frac{n-1}{2}}$ divided by $n = -$ the remainder of $n^{\frac{m-1}{2}}$ divided by $m$; but with a contrary sign. See "Essai sur la Théorie des Nombres," p. 3.

RECITATIVO or RECITATIVE, in Music, a kind of singing that differs but little from ordinary pronunciation, such as that in which the several parts of the liturgy are rehearsed in cathedrals; or that in which the actors commonly deliver themselves on the theatre at the opera, when they are to express some action or passion, to relate some event, or reveal some design.

RECKONING, the art of estimating the quantity of a ship's way, or of the distance run between one place and another. Or more generally, a ship's reckoning is that account whereby at any time it may be known where the ship is, and on what course or courses she is to steer to gain her port. This is usually performed by means of the log-line. *See* LOG-LINE. Yet this is subject to great irregularities. Vitruvius advises an axis to be passed through the sides of the ship with two large heads propending out of the ship, wherein are to be included wheels touching the water, by whose revolution the space passed over in any given time may be measured. The same has been since recommended by Snelling, but there are few who have written on navigation but have shewn the insufficiency of this method.

RECLUSE, among religious, signifies a person shut up in a very narrow cell or hermitage, and secluded from all intercourse with the world and mankind.

RECLINER, in Dialling, is used for any dial whose plane reclines from the perpendicular; and if besides reclining, it also declines from any of the cardinal points, it is called a reclining declining dial, and the quantity or angle at which it declines or reclines, is called its reclination or declination.

RECOGNIZANCE, in Law, is an obligation of record which a man enters into before some court of record, or magistrate duly authorized, with condition to the same particular act, as to appear at the assizes or quarter sessions to keep the peace, &c. If the party does not comply with it, the recognizance is estreated into the exchequer. In some cases the court will upon motion respite, and in some discharge the recognizance; but all parties should be careful to apply in good time to the court where the recognizance is to be returned.

RECOIL, or REBOUND, the starting backward of a fire-arm, after an explosion. This term is particularly applicable to pieces of ordnance, which are always subject to a recoil, according to the sizes and the charges which they contain. To lessen the recoil of a gun, the platforms are generally made sloping towards the embrasures of the battery.

RECORD, an act committed to writing in any of the king's courts during the term wherein it is written, is alterable, being no record; but that term once ended, and the act duly enrolled, it is a record, and of that credit which admits of no alteration or proof to the contrary.

RECORDARI FACIAS, a writ directed to the sheriff, to remove a cause out of an inferior court, into the king's bench or common-pleas.

RECORDE, ROBERT, an eminent English mathematician, of the 16th century, author of several works on arithmetic, algebra, geometry, &c. and which were principally written in the form of dialogues between a master and his pupils.

RECORDER, a person whom the mayor and other magistrates of a city or corporation associate to them, for their better direction in matters of justice and proceedings in law; on which account, this person is generally a counsellor, or other person well skilled in the law.

RECOVERY, in Law, is obtaining any thing by judgment or trial at law. A recovery resembles a fine so far as being an action real or fictitious, and in that lands are recovered against the tenant of the freehold, and an absolute fee-simple is vested in the recovery; but it is carried on through every stage of proceeding, instead of being compromised like a fine.

RECTANGLE, in Geometry, the same with a right-angled parallelogram.

RECTANGULAR FIGURES and SOLIDS, are those which have one or more right angles. With regard to solids, they are commonly said to be rectangular when their axis are perpendicular to the planes of their bases.

RECTANGULAR *Section* of a *Cone*, was a term used by the ancients, before Apollonius, for the parabolic section.

RECTIFICATION, in Geometry, is the finding of a right line equal to a proposed curve; a problem that even in the present state of analysis is, in many cases, attended with some difficulty, and was in all totally beyond the reach of the ancient geometers, who were not able to assign the length of any curve line whatever, though they could, in a few cases, assign the area of a curvilinear space. It is to the doctrine of fluxions that we owe the complete rectification of curve lines, in finite terms, in all cases where they admit of it, and in others by means of infinite series, circular arcs, logarithms, &c.

RECTIFICATION, in Chemistry, the repetition of a distillation or sublimation several times, in order to render the substances purer, finer, and freer from aqueous or earthy parts.

RECTIFIER, an instrumunt used for determining the variation of the compass, in order to rectify the ship's course, &c. It consists of two circles, either laid upon or let into one another, and so fastened together in their centres, that they represent two compasses, the one fixed, the other moveable; each is divided into 32 points of the compass, and 360 degrees, and numbered both ways, from the north and the south, ending at the east and west, in ninety degrees. The fixed compass represents the horizon, in which the north and all the other points are liable to variation. In the centre of the moveable compass is fastened a silk thread, long enough to reach the outside of the fixed compass; but if the instrument be made of wood, an index is used instead of the thread.

RECTILINEAR, in Geometry, right-lined: thus figures whose perimeter consists of right lines are said to be rectilinear.

RECTORY, a parish, church, parsonage, or spiritual living, with all its rights, tithes, and glebes.

RECTUM, in Anatomy, is the last portion of the large intestine, and of the whole alimentary canal. This part of the human body is subject to disease, chiefly with those advanced in years, but young persons swallowing plum and cherry stones are not exempt.

RECURRING SERIES, is a series so constituted that each succeeding term is connected with a certain number of the terms immediately preceding it by a constant and invariable law; as the sums or differences of some multiples of those terms, &c.

RECURRING DECIMALS, those which are continually repeated in the same order, at certain intervals, as $\frac{2}{3} = \cdot6666$, and $\frac{3}{11} = \cdot272727$, &c.

RECUSANT, a person who refuses to go to church, and worship God after the manner of the church of England, as by law established; to which is annexed the penalty of 20l. a month for nonconformity. 24 Eliz. c. 1.

RECURVIROSTRA, the *Avoset* in Natural History, a genus of birds of the order grallæ. There are three species. The scooping avoset, found in this island, as large as the lapwing, has extremely long legs; its bill is three inches and a half in length. In winter it is often seen at the mouth of the Severn and on the coasts of Suffolk. In the fens of Cambridgeshire these birds are known to breed, and appear often in vast flocks. Their subsistence is on insects and worms, which they procure from the soft muddy bottoms with their bills. They often wade into the water to the top of their legs, and are able to swim; but are seldom seen swimming, and never, unless at a very small distance from the shore. In France, on the coasts of Bas Poictou, their nests are plundered annually of several thousands of eggs, which form a nourishing and valuable food for the peasantry of that district.

RED. *See* COLOUR.

RED, in Physics, or Optics, one of the simple or primary colours of natural bodies, or rather of the rays of light. The red rays are the least refrangible of all the rays of light. And hence, as Newton supposes, the different degrees of refrangibility to arise from the different magnitudes of the luminous particles of which the rays consist; therefore the red rays, or red light, is concluded to be that which consists of the largest particles. *See* COLOUR and LIGHT. Authors distinguish three general kinds of red, one bordering on the blue, as colombine, or dove colour, purple, and crimson; another bordering on yellow, as flame colour and orange; and between these extremes is a medium, which is that which is properly called red.

Red *Clover*, in Agriculture, an useful artificial grass fitted for arable lands. It has this name to distinguish it from white clover and some other sorts.

Red *Shank*, in Ornithology, a bird about the size of the common plover. On the back its colour is of a gray or brownish green, spotted with black; its breast white; wings and throat variegated. It breeds in fens and marshes, and during the winter season lies concealed in gutters. Its bill is about two inches long, and in shape resembles that of a woodcock.

Red *Start*, in Ornithology, is a beautiful bird, exquisite in plumage, moves its tail horizontally like a dog when fawning, has black legs, is remarkably shy, but has a soft and melodious note. It is migratory, and is found in this country only in spring and summer.

Red *Wing*, in Ornithology, a bird somewhat smaller than the thrush, and is less spotted. It is a bird of passage, coming on the approach of winter, supposed from the mountains of Germany and Bohemia.

Red *Water*, a disease in sheep, supposed to be caused by their taking too much watery food, such as turnips, clover, rape, &c. Its removal has been attempted by the use of common salt, a tea-spoonful of elixir of vitriol, and keeping the animals in action. A proportion of dry food is the best preventive.

Red *Weed*, is a name sometimes given to the round smooth-headed poppy, a pernicious weed in corn-fields.

Red *Worm*, the name of an insect very destructive to young corn crops. Many experiments have been made on the best means of destroying it, but none have been found altogether effectual.

RED-BOOK, of the *Exchequer*, an ancient record or manuscript volume, in the keeping of the king's remembrancer, containing divers miscellaneous treatises relating to the times before the Conquest.

REDDENDUM, in our Law, is used substantively for the clause in a lease wherein the rent is reserved to the lessor.

REDDLE, Red Ochre, or *Red Chalk*, in Mineralogy, the red oxide of iron united with earthy matter. It is used for crayons either in its natural state, or pulverized, washed, and afterwards mixed with gum, and cast into moulds.

REDEMPTION, in Law, a faculty or right of re-entering upon lands, &c. that have been sold and assigned, upon re-imbursing the purchase-money with legal costs. Bargains wherein the faculty, or as some call it, the equity of redemption is reserved, are only a kind of pignorative contracts.

Redemption, in Theology, denotes the recovery of mankind from sin and death, by the obedience and sacrifice of Christ, who is hence called the Redeemer of the world.

REDOUBT, or Redoute, in Fortification, a small square fort, without any defence but in front, used in trenches, lines of circumvallation, contravallation, and approach, as also for the lodgings of corps de garde, and to defend passages. In marshy grounds, redoubts are frequently made of stone-works for the security of the neighbourhood; their face consists of from 10 to 15 fathoms, the ditch round them from 8 to 9 feet broad and deep, and their parapets have the same thickness.

RED SNOW. The phenomenon of red snow, seen both on the coast of Baffin's bay and at Spitzbergen, has attracted much attention. This colouring matter has been found to have its origin from a very minute fungus which grows upon the snow, and which has been considered a species of uredo, and has been denominated uredo nivalis.

REDUCING Scale, or *Surveying Scale*, is a broad thin slip of box, or ivory, having several lines and scales of equal parts upon it; used by surveyors for turning chains and links into roods and acres by inspection. It is used also to reduce maps and draughts from one dimension to another.

REDUCTION, in Arithmetic, is, by some authors on this subject, distinguished into reduction *ascending*, and reduction *descending*. The former, relating to the conversion of a quantity from a lower denomination to a higher; and the latter, when the quantity is to be reduced from a higher denomination to a lower.

REDUCTION, or Revivification. This word, in its most extensive sense, is applicable to all operations by which any substance is restored to its natural state, or which is considered as such; but custom confines it to operations by which metals are restored to their metallic state, after they have been deprived of this, either by combustion, as the metallic oxides, or by the union of some heterogeneous matters which disguise them, as fulminating gold, luna cornea, cinnabar, and other compounds of the same kind. These reductions are also called revivifications.

REDUNDANT Hyperbola, one of the higher order of hyperbolas, having more than two infinite branches.

REED, in Agriculture, the name of an aquatic plant infesting boggy low lands or meadows on the sides of rivers. Trenches, draining off the moisture by which it is supported, will destroy it. Ashes or soot has sometimes killed this weed.

Reed, is also a term applied to such straw of wheat, oats, or rye, as has not been damaged by thrashing.

Reed *Hedge*, in Gardening, is a hedge-fence which is formed of reeds. It is temporary and moveable, furnishing shelter to many seedlings and plants.

Reeds, in Fireships, are made up in small bundles of about twelve inches in circumference, cut even at both ends, and dipped in a kettle of melted composition, to render them easily ignitible.

REEF, a certain portion of a sail comprehended between the top or bottom and a row of eyelet holes generally parallel thereto. The intention of the reef is to reduce the surface of the sail in proportion to the increase of the wind, for which reason there are several reefs parallel to each other in the superior sails; thus the top sails of ships are generally furnished with three reefs, and sometimes four, and there are always three or four reefs parallel to the foot or bottom of those main-sails and fore-sails which are extended upon booms.

Reef, also implies a chain of rocks lying near the surface of the water.

Reef *Band*, a piece of canvass sewed across the sail to strengthen it in the place where the eyelet holes of the reefs are formed.

Reef-*Line*, a small rope, by which they formerly reefed the courses by passing it spirally through the holes of the reef, and over the head of the sail, alternately from the yard arms to the slings, and then straining it as tight as possible.

Reef-*Tackle*, a tackle upon deck, communicating with its pendant, which passing through a block at the top-mast-head, and through a hole in the top-sail yard-arm, is attached to a cringle a little below the lowest reef. Its use is to pull the skirts of the top-sails close up to the extremities of the top-sail yards, in order to lighten the labour of reefing.

*Close*-Reefed, is when all the reefs of the top-sails are taken in.

REEFING, the operation of reducing a sail by taking in one or more of the reefs, and is either performed with lines, points, or knittles. The top sails are always and the courses generally reefed with points, which are flat braided pieces of cordage, whose lengths are nearly double the circumference of the yard. These being inserted in the eyelet holes, are fixed in the sail by means of two knots in the middle, one of which is before and the other behind the reef-band.

In order to reef the top-sails with more facility and expedition, they are lowered down, and made to shiver in the wind; the extremities of the reef are then drawn up to the yard-arms by the reef-tackles, where they are securely fastened by the earings; the space of sail comprehended in the reef is then laid smoothly over the yard in several folds, and the whole is completed by tying the points about the yard so as to bind the reef up close to it. In reefing a course, the after end of the point should be thrust forward between the head of the sail and the yard, and the fore leg of the same point should come aft over the head of the sail, and also under the yard, and thus crossed over the head of the sail, the two ends should be tied on the upper side of the yard as tight as possible. When a sail is reefed at the bottom, it is generally done with knittles in the room of points, or in large sails, such as the main sails of armed cutters, pieces of line, termed reef-banks, are fixed in the eyelet-holes.

REEL, in the manufactories, a machine serving for the office of reeling. There are various kinds of reels, some very simple, others very complex. Of the former kinds those most in use are, 1. A little reel held in the hand, consisting of three pieces of wood, the biggest and longest whereof, (which does not exceed a foot and a half in length, and one-fourth of an inch in diameter) is traversed by two other pieces disposed different ways. 2. The common reel or windlass, which turns upon a pivot, and has four flights traversed by long pins or sticks, whereon the skein to be reeled is put, and which are drawn closer or opened wider according to the skein.

REELING, in the Manufactories, the winding of thread, silk, cotton, or the like, into a skein.

REELS, are machines moving round an axis, and serving to wind various lines upon, as the

*Deep-Sea*-Reel, that which contains the deep-sea line;

*Log*-Reel, that appropriated for the log-line.

Rectification, in Chemistry, the repetition of a distillation or sublimation several times, in order to render the substances purer, finer, and freer from aqueous or earthy parts.

REEM. *See* Rhinoceros.

REEMING, a term used by caulkers for opening the seams of the planks with irons, for the more easy admission of oakum. In common language, to make any hole larger, is in many places termed reeming.

RE-ENTRY, in Law signifies the resuming or retaking the possession of lands lately lost.

REEVING, in the Sea Language, the putting a rope through a block; hence to pull a rope out of a block is called unreeving.

REFERENCE, in Law, is where a matter is referred by the court of chancery to a master, and by the courts at law to a prothonotary, or secondary, to examine and report to the court. Reference also signifies where a matter in dispute is referred to the decision of an arbitrator. This is done either by parol, agreement, or by bond, or upon a suit, in which latter case the party has a rule of court, that the party against whom the award is made shall perform it, and then he may move to have an attachment against him, if he does not perform it. By statute also this may be done, where the parties agree that the award should be made a rule of court, although there is no suit.

REFINING, in general, is the art of purifying a thing; including not only the assaying or refining of metals, but likewise the depuration or clarification of liquors. Gold and silver may be refined by several methods, which are all founded on the essential properties of the metals, and acquire different names according to their kinds.

REFINING, in Metallurgy, is the means of obtaining metals from their ores, and freeing them from all other impurities, whether natural or artificial. The term is applicable to the purification of things in general.

REFITTING, in sea language, is generally understood to imply the repairing any damages which a ship may have sustained in her sails or rigging by battle or tempest, but more particularly by the former.

REFLECTION, or Reflexion, in Mechanics, is the return or regressive motion of a moveable body, arising from the reaction of some other body on which it impinges. The reflection of bodies after impact is attributable to their elasticity, and the more perfectly they possess this property, the greater will be their reflection, all other things being the same. In case of perfect elasticity, they would be reflected back again with the same velocity, and at an equal angle with which they met the plane; that is, the angle of incidence would be equal to the angle of reflection, and the velocity both before and after impact would be the same, at equal distance from the body on which they impinge.

Reflection of the *Rays* of *Light*, in Catoptrics, is their return, after their approaching so near the surfaces of bodies as to be repelled or driven backwards. *See* Optics.

Reflection of *Heat*. In the same manner as we find the rays of light are reflected by polished surfaces, so it is found that the rays of caloric have precisely the same property. The Swedish chemist, Scheele, discovered, that the angle of reflection of the rays of caloric is equal to the angle of incidence, a fact which has been more fully established by Dr. Herschel. Some very interesting experiments were made by Professor Pictet, of Geneva, which proved the same thing. These experiments were conducted in the following manner:—Two concave mirrors of tin, of nine inches focus, were placed at the distance of twelve feet two inches from each other; in the focus of the one was placed the bulb of a thermometer, and in that of the other a ball of iron two inches in diameter, which was just heated so as not to be visible in the dark. In the space of six minutes the thermometer rose 22°. A similar effect was produced by substituting a lighted candle in place of the ball of iron. Supposing that both the light and heat might act in the last experiment, he interposed between the two mirrors a plate of glass, with the view of separating the rays of light from those of caloric. The rays of caloric were thus interrupted by the plate of glass, but the rays of light were not perceptibly diminished. In nine minutes the thermometer sunk 14°; and in seven minutes after the glass was removed, it rose about 12°. He therefore justly concluded, that the caloric reflected by the mirror was the cause of the rise of the thermometer. He made another experiment, substituting boiling water in a glass vessel in place of the iron ball; and when the apparatus was adjusted, and a screen of silk, which had been placed between the two mirrors, removed, the thermometer rose 3°; namely, from 47° to 50°. The experiments were varied by removing the tin mirrors to the distance of 90 inches from each other. The glass vessel, with boiling water, was placed in one focus, and a sensible thermometer in the other. In the middle space between the mirrors, there was suspended a common glass mirror, so that either side could be turned towards the glass vessel. When the polished side of this mirror was turned towards the glass vessel, the thermometer rose only five-tenths of a degree; but when the other side, which was darkened, was turned towards the glass vessel, the thermometer rose 3° 5′. And in another experiment, performed in the same way, the thermometer rose 3° when the polished side of the mirror was turned to the glass vessel, and 9° when the other side was turned, which experiments shew clearly, that the rays of caloric are reflected from polished surfaces, as well as the rays of light. Transparent bodies have the power of refracting the rays of caloric as well as those of light. They differ also in their refrangibility. So far as experiment goes, the most of the rays of caloric are less refrangible than the red rays of light. The experiments of Dr. Herschel shew that the rays of caloric, from hot or burning bodies, as hot iron, hot water, fires, and candles, are refrangible, as well as the rays of caloric which are emitted by the sun. Whether all transparent bodies have their power of transmitting these rays, or what is the difference in the refractive power of these bodies, is not yet known.

The light which proceeds from the sun seems to be composed of three distinct substances. Scheele discovered that a glass mirror, held before the fire, reflected the rays of light, but not the rays of caloric; but when a metallic mirror was placed in the same situation, both heat and light were reflected. The mirror of glass became hot in a short time, but no change of temperature took place on the metallic mirror. This experiment shews that the glass mirror absorbed the rays of caloric, and reflected those of light; while the metallic mirror, suffering no change of temperature, reflected both. And if a plate of glass be held before a burning body, the rays of light are not sensibly interrupted, but the rays of caloric are intercepted; for no sensible heat is observed on the opposite side of the glass; but when the glass has reached a proper degree of temperature, the rays of caloric are transmitted with the same facility as those of light. And thus the rays of light and caloric may be separated; and the curious experiments of Dr. Herschel have clearly proved, that the invisible rays which are emitted by the sun have the greatest heating power. In these experiments, the different coloured rays were thrown on the bulb of a very delicate thermometer, and their heating power was observed. That of the violet, green, and red rays, were found to be to each other as the following numbers:—

Violet, 16 0;....Green, 22 4;....Red, 55 0.

The heating power of the most refrangible rays was least, and this increases as the refrangibility diminishes. The red ray, therefore, has the greatest heating power, and the violet, which is the most refrangible, the least. The illuminating power, it has been already observed, is greatest in the middle of the spectrum, and diminishes towards both extremities; but the heating power, which is least at the violet end, increases from that to the red extremity, and when the thermometer was placed beyond the limit of the red ray, it rose still higher than in the red ray, which has the greatest heating power in the spectrum. The heating power of these invisible rays was the greatest at the distance of half an inch beyond the red ray, but it was sensible at the distance of one inch and a half.

REFLECTING CIRCLE, an astronomical instrument for measuring angles. It is called reflecting from its property, in common with the Hadley's quadrant, (of which it is a modification) of observing one of the objects of the angle to be measured by distinct vision, and the other by reflection of plane mirrors.

REFLECTOIRE CURVE, is a term given by Mairan to the curvilinear appearance of the plane surface of a bason containing water to an eye placed perpendicularly over it. In this position the bottom of a bason will appear to rise upwards from the centre outwards, but the curvature will be less and less, and at last the surface of the water will be an asymptote to it.

REFLECTOR, a mirror or looking-glass.

REFLEXIBILITY, the property necessary for reflection.

REFLUX of the SEA. *See* TIDE.

REFORM, a revival of former discipline, a re-establishment of partially neglected or abandoned principles, or a correction of some reigning abuses in them.

REFORMATION, the act of correcting abuses. More emphatically, the term is applied to the throwing off the papal yoke, about the beginning of the sixteenth century. To this noble act we are indebted for the religious privileges we enjoy, and many of our civil blessings may be traced to the same source.

REFRACTED ANGLE, or *Angle of Refraction*, is the angle which a refracted ray makes with the surface of the refracting body. The complement of this angle is, however, sometimes called the refracted angle.

REFRACTION of the rays of light. *See* OPTICS.

REFRACTION, in Astronomy, is an inflection of the rays of light proceeding from the heavenly bodies, in passing through the atmosphere by which their apparent altitudes are increased.

*Atmospherical* REFRACTION. It is evident, from the nature and progression of light, that rays, in passing from any object through the atmosphere, or part of it, to the eye, do not proceed in a right line; but the atmosphere being composed of an infinitude of strata, (if we may so call them,) whose density increases as they are posited nearer the earth, the luminous rays which pass through it are acted on as if they passed successively through media of increasing density, and are, therefore, inflected more and more towards the earth as the density augments. In consequence of this it is, that rays from objects, whether celestial or terrestrial, proceed in curves which are concave towards the earth: and thus it happens, since the eye always refers the place of objects to the direction in which the rays reach the eye, that is, to the direction of the tangent to the curve at that point, that the apparent or observed elevations of objects are always greater than the true ones. The difference of these elevations, which is in fact the effect of refraction, is, for the sake of brevity, called refraction; and it is distinguished into two kinds, horizontal, or terrestrial, refraction, being that which effects the altitude of hills, towers, and other objects on the earth's surface; and astronomical refraction, or that which is observed with regard to the altitudes of heavenly bodies. Refraction is found to vary with the state of the atmosphere in regard to heat or cold, and humidity, so that determinations obtained for one state of the atmosphere, will not answer correctly for another without modification. Tables commonly exhibit the refraction at different altitudes, for some assumed mean state.

REFRACTION of *Altitude*, is an arc of a vertical circle, by which the altitude of a star is increased by the refraction.

REFRACTION of *Ascension* or *Descension*, is an arc of the equator by which the ascension or descension, whether right or oblique, is increased or diminished by refraction.

REFRACTION of *Declination*, is the increase or decrease in the declination of a star by refraction.

REFRACTION, in Latitude, is the increase or decrease of the latitude of a star from refraction.

REFRACTION, in Longitude, is the increase or decrease in the longitude of a star from refraction.

REFRACTION, in Mechanics, is the deviation of a body in motion, from its direct course, in consequence of the variable density of the mediums in which it moves. This, however, except in speaking of the rays of light, is commonly called *deflection*.

REFRACTION, in Iceland crystal. There is a double refraction in this substance, contrary ways, by which not only oblique rays are divided into two, and refracted into opposite parts, but even perpendicular rays are one half refracted.

REFRANGIBILITY of LIGHT, the property of the rays to be refracted, but more commonly employed with reference to the different degrees in which the different rays possess this property; and on which Newton has founded his whole theory of colours. For the several experiments relating to this subject, see PRISM.

REFRIGERATION, the act of cooling, or the abstracting of heat from various substances, for the purpose of art or domestic use.

REFUGE, in antiquated customs, a sanctuary or asylum. In the Old Testament, six cities of refuge were appointed for the protection of persons from the rigour of the law, who were guilty of involuntary homicide.

REFUGEES, French Protestants who, on the revocation of the edict of Nantz in 1685, fled from persecution, and found shelter in Holland, Germany, and England, where they carried many valuable arts, by which these countries have been enriched and France has been empoverished.

REGAL, something belonging to a king. Regal is is also a musical term, and likewise a species of portable organ much used in processions in papal countries.

REGALE, in French jurisprudence, is a right belonging to the king over all benefices in that kingdom. It consists in the enjoyment of the revenues of bishops' sees during their vacancy, and in the presentment to benefices dependent on them.

REGALIA, in Law, the rights and prerogatives of a king, which, according to the civilians, are six, *viz.* 1. The power of judicature; 2. the power of life and death; 3. the power of peace and war; 4. a right to such goods as have no owner, as waifs, estrays, &c. 5. assessments; and 6. the coinage of money. Regalia is also used for the apparatus of a coronation, as the crown, the sceptre with the cross, and with the dove, St. Edward's staff, the globe, and the orb with the cross, four several swords, &c.

REGARDANT, in Heraldry, is understood of a lion or other beast of prey, in the attitude of looking behind him with his eyes towards his tail.

REGARDANT *Villain*, an ancient servant or retainer to the lord, because charged with the base services within the manor, to see that all filth and nuisances are removed.

REGARDER of the FOREST, an ancient officer, whose business it was every year to make oath to the limits of the forest, and also to inquire into all offences committed within its jurisdiction.

REGATTA, a name given in Venice to exhibitions on the water, such as a contest for superiority in rowing and the management of boats.

REGEL, or RIGEL, a fixed star of the first magnitude, in the left foot of Orion.

REGENERATION, in Theology, the act of being born again by a spiritual birth, or becoming a child of God, through which the person abandons a course of vice, and leads a life of piety and virtue.

REGENT, one who governs a kingdom during the minority or absence of the king. In France the queen mother has the regency of the kingdom during the minority of the king, under the title of the queen regent. Regent also signifies a professor of arts and sciences in a college, who has a set of pupils under his care; but here regent is generally restrained to the lower classes, as regent of rhetoric, regent of logic, &c. those of philosophy are rather called professors. The foreign universities are generally composed of doctors, professors, and regents.

REGERENDARIUS, among the Romans, was an officer who subscribed and kept a register of all petitions presented to the prefect.

REGICIDE, a king-killer. The term is also used for the act of murdering the king. It is now generally applied to those persons who were engaged in the trial, condemnation, and execution of Charles I.

**REGIMEN**, the regulation of diet, and, in a more general sense, of all the nonnaturals, with a view to preserve or restore health.

**Regimen**, in Grammar, that part of syntax or construction which regulates the dependency of words, and the alteration which one occasions in another.

**REGIMENT**, in War, is a body of men, either horse or foot, commanded by a colonel. Each regiment of foot is divided into companies, but the number of companies is not always alike, though our regiments generally consist of ten companies, one on the right, of grenadiers, and another on the left, of light troops. Regiments of horse most commonly consist of six troops, but some have nine. Regiments of dragoons, in time of war, are generally composed of eight troops, and in time of peace of six.

**REGINA Aurarum**, in Ornithology, a large Mexican bird about the size of an eagle. Its whole body is covered with a plumage of a blackish purple. Its feet are red, its beak like that of a parrot; it feeds on rats, mice, snakes, and other vermin, and can fly against the fiercest wind.

**REGION**, in Physiology, particular districts on the surface of the globe, disposition of internal strata, and distinguished elevations in the atmosphere, and depths in the sea.

**Region**, in Anatomy, denotes the division of the human body.

**REGIONARY**, in Ecclesiastical History, a title given in the fifth century to persons who had the charge and administration of church affairs within a certain district or region.

**REGIS, Peter Sylvain**, a French philosopher, was born in 1632, author of a "System of Philosophy," in 3 vols. 4to. published in 1690, and some other works. He died in 1707, at 75 years of age.

**REGISTER**, a public book, in which is entered and recorded memoirs, acts, and minutes, to be had recourse to occasionally, for knowing and proving matters of fact. Of these there are several kinds: as, 1. Registers of deeds in Yorkshire and Middlesex, in which are registered all deeds, conveyances, wills, &c. that affect any lands or tenements in those counties, which are otherwise void against any subsequent purchasers or mortgagees, &c. but this does not extend to any copyhold estate, nor to leases at a rack-rent, or where they do not exceed 21 years. The registered memorials must be engrossed on parchment, under the hand and seal of some of the grantors or grantees, attested by witnesses who are to prove the signing or sealing of them, and the execution of the deed. But these registers, which are confined to two counties, are in Scotland general, by which the laws of north Britain are rendered very easy and regular. Of these there are two kinds; the one general, fixed at Edinburgh, under the direction of the Lord Register; and the other is kept in the several shires, stewartries, and regalities, the clerks of which are obliged to transmit the registers of their respective courts to the general register. No man in Scotland can have a right to any estate, but it must become registered within forty days of his becoming seised thereof; by which means all secret conveyances are cut off. 2. Parish registers are books in which are registered the baptism, marriages, and burials, of each parish.

**Register**, is also used for the clerk or keeper of a register. Of these we have several, denominated from the registers they keep: as, register of the high court of delegates; register of the arches court of Canterbury; register of the court of admiralty; register of the prerogative court; register of the garter, &c.

**Register**, in Printing, is disposing the forms on the press, so that the lines and pages printed on one side of the sheet fall exactly on those of the other.

**Register**, among letter-founders, is one of the inner parts of the mould in which the printing types are cast. Its use is to direct the joining of the mould justly together again, after opening it to take out the new-cast letter.

**REGIUS Professors.** Henry VIII. founded five lectures in each of our universities, *viz.* Divinity, Hebrew, Greek, Law, and Physic, the readers of which lectures are in the universities' statutes called *regii professores.*

**REGLE**, in Music, a rule for accompanying the octave ascending and descending in the base, giving to each note of the scale its appropriate harmony in every key.

**REGLETS**, or **Riglets**, in Printing, are thin slips of wood exactly planed to the size of the body of the letter. The smaller sorts are placed between the lines of poetry, and both those and larger are used in filling up short pages, in forming the whites or distances between the lines of titles, and in adjusting the distances of the pages in the chase, so as to form register.

**REGRATOR**, or **Regrater**, in Law, formerly signified one who bought wholesale, or by the great, and sold again by retail; but the term is now used for one who buys any wares or victuals, and sells them again in the same market or fair, or within five miles round it.

**Regrator**, is also used for one who furbishes up old moveables to make them pass for new. And masons who take off the outside surface of hewn stone, in order to whiten it, or make it look fresh again, are said to regrate.

**REGRESSION.** *See* Retrogression.

**REGULAR**, denotes any thing that is agreeable to the rules of art; thus we say a regular building, verb, &c. A regular figure in Geometry is one whose sides, and consequently angles, are equal; and a regular figure with three or four sides, is commonly termed an equilateral triangle or square, as all others with sides are called regular polygons. All regular figures may be inscribed in a circle. A regular solid, called also a platonic body, is that terminated on all sides by regular and equal planes, and whose solid angles are all equal.

**Regular** *Bodies*, are those which have all their sides, angles, and faces, similar and equal. Of these there are only five, *viz.*

the *Tetraedon*, contained by four equilateral triangles;
the *Hexaedron*, or *cube*, by six squares;
the *Octaedron*, by eight triangles;
the *Dodecaedron*, by twelve pentagons; and
the *Icosaedron*, by twenty triangles.

For the properties of which see the several articles; see also Hutton's "Mensuration," sect. 2.

**REGULATING Captain**, an officer whose duty it is to examine the seamen intended for the navy, whether pressed or volunteers.

**REGULATOR of a Watch**, the small spring belonging to the balance, serving to adjust its motions, and make it go faster or slower

**Regulator** of *Velocity*, in Mechanics, is a contrivance for regulating or governing the motions of a mill, or other machinery, causing the motion of its parts to preserve an equable velocity, under all the variations of the propelling cause.

**REGULUS.** The name regulus was given by chemists to metallic matters when separated from other substances by fusion.

**Regulus**, a fixed star of the first magnitude in the constellation Leo; sometimes called *Cor Leonis*, or Lion's Heart. By the Arabians it was termed Alhabor, and by the Chaldeans Kalbeleceid.

**REHEARING**, in the Court of Chancery, is a process to which either party, who thinks himself aggrieved, may have recourse, before the execution of a final decree.

**REHEARSAL**, in Music and the Drama, is an experiment on some composition in private, that the actors may better understand their parts.

**REIGNING Winds**, a name given to the winds which usually prevail on any particular coast or region. *See* Wind.

**REIMBURSEMENT**, in Commerce, the act of repaying what monies had been received by way of advance. A person who gives a bill of exchange in payment, is to reimburse it, if protested, or not paid.

**REIN DEER**, in Zoölogy. This species of the deer kind is generally described as having horns ramose, recurvated round with palmated summits. When full-grown, this animal, according to Pennant, is four feet six inches high, the body of a somewhat thick and square form, and the legs shorter than those of the common stag. The general colour is brown above and white beneath, but advancing in age it frequently becomes of a greyish white, and sometimes almost black. Both sexes are furnished with horns; those of the male are much larger and longer than those of the female. To the Laplander this animal is considered as the common substitute of the horse, the cow, the sheep, and the goat. The milk furnishes cheese, the flesh food, the skin clothing, the tendons bow-strings, and, when split, thread, the horns glue, and the bones spoons. A Laplander is sometimes possessed of a thousand deer. Their chief food is a species of moss, which covers vast tracts of the northern regions. This they find in abundance during the summer, but in winter their fodder is scarce, and then the greatest care and attention are required for their support. Trained when young to draw the sledge, their services are of the utmost importance when grown to maturity. They will then proceed about thirty miles per day without sustaining any injury, and sometimes, when pressed, from fifty to sixty; but such journeys generally prove fatal to the animal. The rein deer is a native of the northern regions. In Europe its chief residence is Norway and Lapland. In Asia, Siberia and Kamtschatka. In America, Greenland and the neighbourhood of Hudson's Bay, but it is rarely found to the south of Canada. A few years since an attempt was made to introduce the breed into this country, but success did not equal expectation. The common deer are more preserved in England than in any other country. They are said to have been first introduced into Scotland from Norway by James I. and from thence into South Britain. They now abound in almost every county. Of these animals, under the generic term Cervus, there are many species, differing from each other in habit and appearance, the particulars of which may be found in works on natural history.

REINHOLD, Erasmus, an eminent German mathematician and astronomer, was born in Upper Saxony in 1511, and died in 1553, in his 42nd year. Reinhold was author of several works, of which only the four following were published, *viz.* 1. Theoriæ novæ Planetarum G. Purbachii, 8vo. 1542, and again in 1580. 2. Ptolemy's Almagest, the first book in Greek, with a Latin version and Scholia, 8vo. 1549. 3. Prutenicæ Tabula Cœlestium Mutuum, 4to. 1551; 2nd edition in 1571; 3d, 1585. 4. Primus Liber Tabularum Directionum, or Tables of Tangents to every minute of the quadrant. And new Tables of Climates, Parallels, and Shadows, with an Appendix, containing the second book of the Canon of Directions, in 4to. 1554. Besides these works, Reinhold was author of several others, which were never published.

REINS, in Anatomy, the kidneys: in Horsemanship, long leathers fastened to the bit of the bridle, by which the horse is kept in subjection.

REINSURANCE, in Commerce, a contract by which the first insurer relieves himself from the risks he had undertaken, and devolves them upon other underwriters, called re-insurers.

REITERATION, the art of repeating a thing, or doing it a second time.

REJOINDER, in Law, is the defendant's answer to the plaintiff's replication or reply.

REJOINTING, in Architecture, the filling up of joints of the stone in old buildings, when worn by time, and the action of the elements.

RELAPSE, in Medicine, the return of a disease when its virulence appeared to have been subdued, and the patient was regaining health.

RELATION, in Philosophy, the mutual respect of two things, or what each is in regard to the other. Hence, relation may be moral, physical, or ideal; but some comparison or affinity is always implied in that which has only a relative existence.

Relation, in Kindred, denotes degrees of consanguinity. In Grammar, relation is the correspondence which words have with one another in construction. In Logic, it is an accident of substance, accounted one of the ten categories, or predicaments.

Relation, in Mathematics, is the same as Ratio, though we sometimes use it in a more general sense, indicating any dependence of one quantity upon another.

RELAXATION, in Law. *See* Release.

RELAY, a fresh equipage, horse, &c. sent before, or appointed to be ready for a traveller on his arrival, to make the greater expedition in his journey.

RELEASE, in Law, is an instrument in writing, by which estates, rights, titles, entries, actions, and other things, are extinguished and discharged; and sometimes transferred, abridged, or enlarged: and in general, it is to signify a person's giving up or discharging the right or action he has, or claims to have, against another, or his lands, &c. A release may be either in fact or in law; a release in fact is where it is expressly declared by the very words, as the act and deed of the party; and a release in law, is that which acquits by way of consequence, as where a female creditor takes the debtor to be her husband.

RELEGATION, a kind of exile or banishment, by which an obnoxious person is commanded to retire to a certain place prescribed, and to remain until recalled or removed.

RELICS, in the Romish church, are the remains of some body, clothes, or furniture, said to have belonged to a saint or martyr, devoutly preserved in honour of his memory, and carried in procession, kissed, and venerated. To these relics superstition has attached miraculous powers, and in this mummery that church has carried on a profitable trade for many centuries.

Relict, in Law. *See* Widow.

RELIEF, in Law, a certain sum of money which the tenant holding by knight's service, grand sergeantry, or other tenure, and being at full age at the death of his ancestor, paid to his lord at his entrance.

RELIEVE, in Military language, is to take the place of another.

Relieve, in Chancery, denotes an order sued out for the dissolving of contracts, and other acts done, on account of their being unreasonable, prejudicial, or grievous.

RELIEVING Tackles, two strong tackles, furnished each with guys and pendants, which, passing under the ship's bottom to the opposite side, are attached to the lower gun-ports; the tackles being hooked to the wharf or pontoon, by which the vessel is careened. They are used to prevent a ship from overturning on the careen, and to assist in bringing her upright after that operation is finished. *Relieving Tackles*, are also those which are occasionally hooked to the tiller in bad weather or in action, when the wheel or tiller-rope is broken or shot away. *Relieving Tackle*, is also a name sometimes given to the train-tackle of a gun carriage.

RELIEVO, or Relief, are terms applied to that mode of working in sculpture by which figures are made to project from the ground or body on which they are formed, and to which they remain attached. The same term is used, whether the figure is cut with the chisel, modelled in clay, or cut in metal or plaister. There are three kinds of relievo: Alto-relievo, or high relief, when the figures are so prominent from the ground that merely a small part of them remains attached to it. Mezzo-relievo, or half relief, when one half of the figure rises from the ground, in such a manner that the figure appears divided by it. Basso-relievo, or bas-relief (low relief), when the work is raised but little from the ground, as in medals, and generally in friezes and other ornamented parts of buildings. Bas-relief is the comprehensive term by which all works in relievo are denominated indiscriminately. *See* Sculpture.

RELIGION, is that worship or homage which is due to God considered as Creator and Preserver, and, with Christians, as Redeemer of the world. The foundation of all religion is, that there is a God, and that for his infinite perfections and innumerable favours he requires some acknowledgment and service from his creatures. Hence religion necessarily supposes some intercourse between God and Man. Religion has been divided into two branches, natural and revealed. The existence of the former has been disputed, and the latter has been subject to an endless diversity of interpretations. The thirty-nine articles of the established church of England are presumed to include the essentials of Christianity, and seditious words spoken in derogation of its truth are indictable as tending to a breach of the peace. 1 Haw. 7.

RELIQUA, in Natural History, a term used to express the fossil remains of various animal, vegetable, and other substances, found in a state of petrifaction, in different parts of the earth. Mr. Martin divides them into five classes, namely, fossil remains of animals or plants, earths, salts, inflammable substances, and metallic substances. Of these, the history is both curious and interesting.

RELIQUÆ, in Antiquity, the ashes and bones of the dead, which remain after the body had been burnt. These were carefully gathered up, and put into urns, and afterwards deposited in tombs.

RELIQUARY, a shrine or casket in which the relics of saints are kept.

**RELL**, the English name of the white-bellied mouse, with a blackish back and a long tail.

**REMAINDER**, that which arises by subtracting one quantity from another.

**Remainder**, in Law, is an estate limited in lands, tenements, or rents, to be enjoyed after the expiration of another particular estate. As if a man seised in fee-simple grant lands to one for twenty years, and, after the determination of the said term, then to another, and his heirs for ever; here the former is tenant in years, remainder to the latter in fee. Both interests are, in fact, only one estate; the present term of years, and the remainder afterwards, when added together, being equal only to one estate in fee. When the remainder is limited in a will, it is sometimes called an executory devise. This is not strictly a remainder, but something in nature of a remainder, which, though informal and bad, as such, is held good as an executory devise. The doctrine of remainders is very abstruse, chiefly from the difficulty of ascertaining from the form of the deed or will by which it is created, whether or not the remainder is contingent, and liable to be defeated. Where a remainder is limited after an estate tail, the tenant in tail can at all times, by suffering a recovery, defeat the remainder, and get possession of the fee. This is called docking the entail, and it is allowed for the purpose of preventing limitations in perpetuity. For, otherwise, men of large landed estates would be enabled to tie up the inheritance so strictly by will, that in a few years all the landed property in the kingdom would be vested for ever in certain families, and that circulation of wealth, which is the great spur to industry, would be wholly at an end.

**REMANCIPATION** was a form of divorce among the Romans, which was connected with some curious formalities.

**REMEDY**, in Law, is the action or means given by law for the recovery of any supposed right.

**Remedy**, in Medicine, is any physical agent by which a disease may be alleviated or cured.

**REMEMBRANCERS**, anciently called clerks of the remembrance, certain officers in the exchequer, whereof three are distinguished by the names of the king's remembrancer, the lord treasurer's remembrancer, and remembrancer of the first fruits.

**REMINISCENCE**, is that power of the mind by which it recals things which had been forgotten. In this respect it differs from memory with uninterrupted remembrance, while reminisiscence allows intervals of forgetfulness. The ancient Platonists were of opinion, that all learning, knowledge, and invention, consisted in the recollection of notices which had been in the soul prior to its union with the body.

**REMISSION**, in Law, is the pardon of a crime. In Medicine, it is the abatement of a disorder, which returns again after an interval. In Physick, it is the diminution of the power or efficacy of any quality.

**REMIT**, in Commerce. To remit a sum of money, bill, or the like, is to send the sum of money, &c.

**REMITTER**, in Law, is where one that has a right to lands, but is out of possession, has afterwards the freehold cast upon him by some subsequent defective title, and enters by virtue of that title.

**REMONSTRANCE**, an expostulation, or humble supplication, presented to the king, or other superior, praying him to reflect on the inconveniences of specific edicts or measures. It also implies a gentle reproof, but touched in a delicate manner.

**REMONSTRANTS**, a title given to the Arminians, in consequence of their remonstrance in 1610, to the states of Holland, against the synod of Dort, in which their principles were condemned.

**REMOVER**, in Law, is where a suit is removed or taken out of one court into another; and is the opposite of remanding a cause, or sending it back into the same court whence it was first called.

**RENCOUNTER**, the encounter of two small bodies detached from the main army; also a combat between two individuals, distinct from a duel, being without premeditation.

**RENDER**, in Law, a term used in the levying of a fine.

**RENDERING**, is usually expressed of a complicated tackle, laniard, or lashing, when the effect of the power applied is communicated with facility to all the parts without being interrupted. It is therefore used in contradistinction to jamming or sticking fast.

**RENDEZVOUS**, the port or place of destination, where the several ships of a fleet or squadron are appointed to join company, or to rejoin in case of separation.

**Rendezvous**, a name given to any house where a press-gang resides, and volunteers are invited to enter into the navy. Also, a place appointed to meet in, at a certain day and hour.

**RENDLING Curd**, in rural economy, a term used to signify the broken curd in cheese-making.

**RENEGATE**, a person who has apostatized from the Christian faith, and embraced some other mode of religion, particularly Mahometanism.

**RENITENCY**, in Philosophy, is that force in solid bodies, by which they resist the impulse of other bodies, or re-act as much as they are acted upon.

**RENNET**, in rural economy, a term applied to the coagulum for making cheese. It is prepared from the bag, maw, or stomach of the young calf, by a salt pickle. The preparations are various; but in the making of cheese much depends upon having a good sweet rennet.

**RENT**, is a certain profit issuing yearly out of lands and tenements corporeal. There are at common law three kinds of rents; rent service, rent charge, and rent seck, or rack rent: Rent service is where the tenant holds his land of his lord by fealty and certain rent; or by homage, fealty, and certain rent; or by other service and certain rent; and it is called a rent service because it has some corporeal service incident to it, which at least is fealty. Rent charge is so called because the land for payment of it is charged with a distress. Rent seek, or rack rent, is where the land is granted without any clause of distress for the same. The time for payment of rent, and consequently for a demand, is such a convenient time before the sun-setting of the last day, as will be sufficient to have the money counted; but if the tenant meets the lessor on the land at any time of the last day of payment, and tenders the rent, that is sufficient tender, because the money is to be paid indefinitely on that day, and therefore tenders on that day is sufficient.

**RENTAL**, a roll in which the rents of a manor are entered, and from which they are collected, and the amount is ascertained.

**REPAIR**, the operation of repairing any injuries, or supplying any deficiencies, which a ship may suffer from age, battle, storm, accident, &c. The repair is necessarily greater or smaller in proportion to the loss which the vessel has sustained. Accordingly a suitable number of the timbers, beams, or planks, or a sufficient part of either, are removed, and new pieces fixed in their places. The whole is completed by breaming, caulking, and paying the body with a new composition of stuff. *See* Breaming, &c.

**REPARTEE**, a ready smart reply, especially in matters of wit, humour, or raillery.

**REPEALING**, in Law, the revoking or annulling of any statute, deed, &c.; but no act of parliament can be repealed in the same session in which it was made.

**Repeating** *Mechanism*, in Horology, is a mechanical contrivance, by which a clock or watch is made to repeat the hours and quarters of existing time, so that a person in the dark, or in bed, may know the time by night, as well as by day. Barlow, a clock-maker of London, in 1676, had the honour of this invention.

**REPEAT Signals**, *To*, is to make the same signal with the admiral, in order to its being more readily distinguished at a distance, or through smoke, &c. *To Repeat a Signal*, sometimes implies to repeat a signal over again, on account of its not having been attended to the first time. The repeat is usually accompanied with a gun.

**REPEATING-SHIP**, is a vessel (usually a frigate) appointed to attend each admiral in a fleet, and to repeat every signal he makes, with which she immediately sails the whole length of the fleet or squadron, if the signal is general, or to the ship for which it is intended, if particular, and then returns to her station near the admiral's ship.

**REPELLENT Medicines**, are those which prevent such an afflux of fluids to any part as would excite tumor or inflammation, or to diminish that already produced.

**REPELLING** Power, in Physics, is a power or faculty residing in, and exerted by, the minute particles of natural bodies, by which they mutually recede from each other.

**REPERCUSSION.** *See* Reflection.

**REPERTORY,** a place in which things are orderly disposed, so as easily to be found when wanted. Hence, indices of books are repertories.

**REPETEND,** in Arithmetic, denotes that part of an infinite decimal which is continually repeated *ad infinitum*, and is otherwise called a *circulate*.

**REPETITION,** in Music, denotes a reiterating or playing over again the same part of a composition, whether it is a whole strain, part of a strain, or double strain, &c.

Repetition, in Rhetoric, a figure which gracefully and emphatically repeats either the same word, or the same sense in different words.

**REPLANTING,** in Gardening, the act of planting trees, shrubs, or flowers, a second time. Many plants require this process, to prevent them from degenerating.

**REPLEADER.** Whenever a repleader is granted, the pleadings must begin de novo at that stage of them, whether it is the plea, replication, rejoinder, or whatever else, wherein there appears to have been the first default or deviation from the regular course.

**REPLEGIARE,** a writ brought by one whose cattle are distrained and put in pound by another, upon security given the sheriff to pursue or answer the action at law, against the distrainer.

**REPLETION,** in the Canon Law, is where the revenue of a benefice is sufficient to fill or occupy the whole right of the graduate who holds it. Where there is repletion, the party can demand no more by virtue of his degrees.

**REPLEVIN,** in Law, is a writ by him who has cattle or other goods distrained by another, for any cause. If he wishes to dispute the propriety of the distress, he sues this writ, and upon putting in surety to the sheriff, that upon delivery of the thing distrained, he will prosecute the action against the distrainer, the cattle or goods are delivered back, and are said to be replevied. In this writ, or action, both the plaintiff and defendant are called actors; the one, that is the plaintiff suing for damages, and the defendant, who is also called avowant, to have a return of the goods or cattle. If the replevin be determined for the plaintiff, namely, that the distress was wrongfully taken, he has already got his goods back into his own possession, and shall keep them, and recover damages. But if the defendant prevail, by the default or non-suit of the plaintiff, then he shall have a writ de returno habendo, or to have a return, whereby the chattels which were distrained and then replevied, are returned again into his custody, to be sold, or otherwise disposed of, as if no replevin had been made. If the distress were for damage feasant, that is, for cattle breaking through fences, and coming upon the land of the party, the distrainer may keep the goods so returned, until tender shall be made of sufficient amends.

**REPLICATION,** in Logic, the assuming or using the same term twice in the same proposition.

Replication, an exception or answer of the plaintiff in a suit to the defendant's plea; and is also that which the complainant replies to the defendant's answer in chancery, &c.

**REPORT,** in Law, is a public relation of cases judiciously argued, debated, resolved, or adjudged, in any of the king's courts of justice, with the causes and reasons of the same, as delivered by the judges.

**REPOSE,** in Painting, certain masses or large assemblages of light and shade, which being well conducted, prevent the confusion of objects and figures, by engaging and fixing the eye, so that it cannot attend to the other parts of the painting for some time; and thus leading it to consider the several groups, gradually proceeding from stage to stage.

Repose, *Angle of*, an angle of 35°.

**REPOSITORY,** a storehouse, or place where things are laid up or kept.

**REPRIMAND,** a sharp authoritative reproof. In military discipline a reprimand is deemed a severe punishment.

**REPRESENTATION.** There is a heir by representation, where the father dies in the life of the grandfather, leaving a son, who shall inherit the grandfather's estate, before the father's brother, &c.

**REPRESENTATIVE,** one who personates or supplies the place of another, and is invested with his right and authority. The Commons are presumed to be the representatives of the people in parliament.

**REPRIEVE,** to suspend a prisoner from the execution and proceeding of the law at the time.

**REPRISAL,** or Reprise, is the retaking a vessel from the enemy soon after the first capture, or at least before she has arrived in any neutral or hostile port. If a vessel thus retaken, has been twenty-four hours in the possession of the enemy, she is deemed a lawful prize; but if retaken within that time, she is to be wholly restored to the owner, upon his allowing one-third of her value for salvage to the recaptors. Also, if a vessel has, from any cause, been abandoned by the enemy before he has taken her into any port, she is to be restored to the original proprietor.

**REPRISE,** or Reprize, at sea, is a merchant ship which, after its being taken by a corsair, privateer, or other enemy, is retaken by the opposite party. If a vessel thus retaken has been twenty-four hours in the hands of the enemy, it is deemed a lawful prize; but if it be retaken within that time, it is to be restored to the proprietors, with every thing therein, upon his allowing one-third to the vessel who made the reprise. Also, if the reprise has been abandoned by the enemy, either in a tempest or any other cause, before it has been led into any port, it is to be restored to the proprietor.

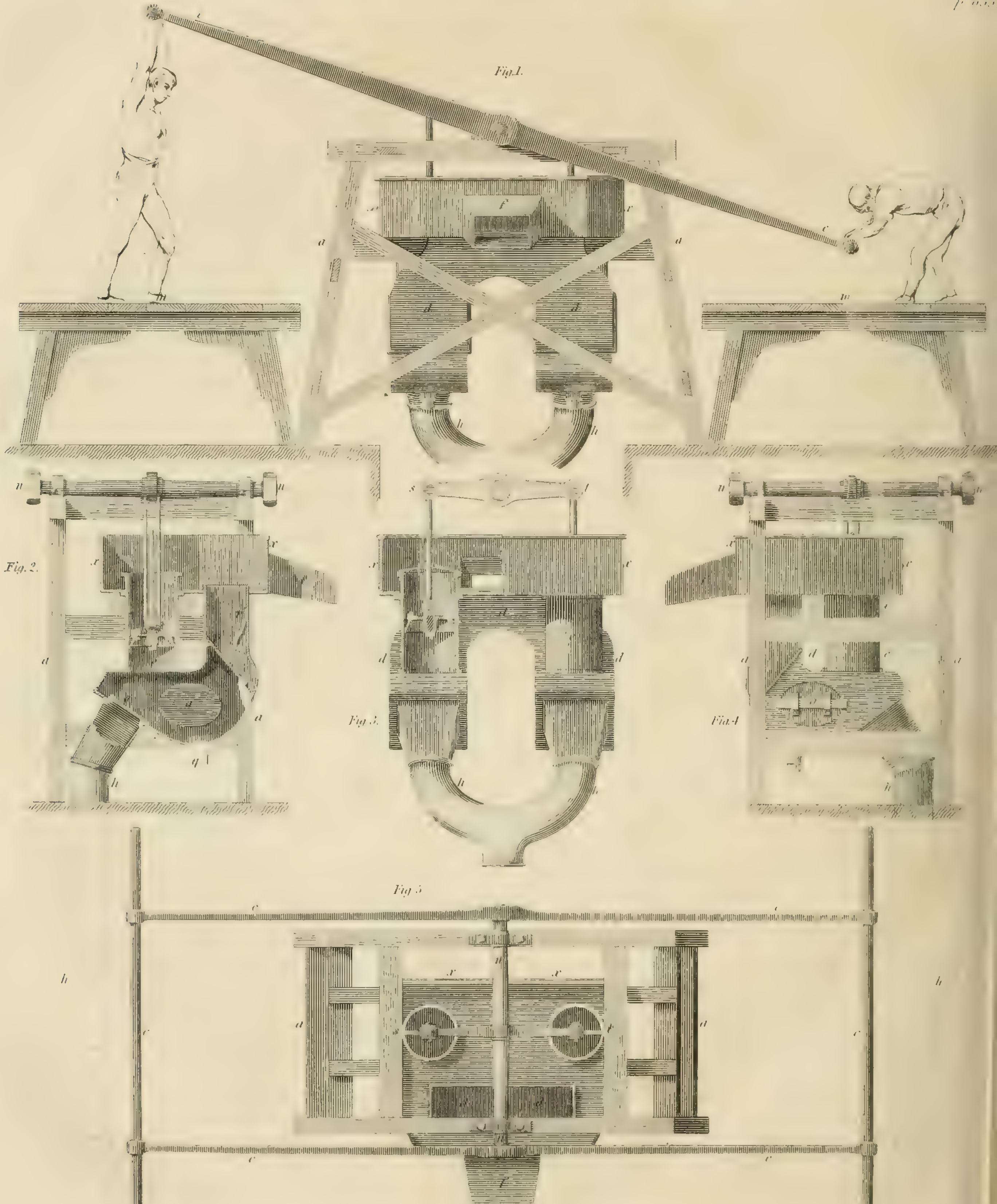
**REPRODUCTION,** is usually understood to mean the restoration of a thing before existing, and since destroyed. It is very well known that trees and plants may be raised from slips and cuttings; and some late observations have shewn that there are some animals which have the same property. The polype (*See* Hydra) was the first instance we had of this kind; but we had scarcely time to wonder at the discovery M. Trembley had made, when M. Bonett discovered the same property in a species of water-worm. Among the plants which may be raised from cuttings, there are some which seem to possess this quality in so eminent a degree, that the smallest portion of them will become a complete tree again. A twig of willow, poplar, and many other trees, being planted in the earth, takes root, and becomes a tree, every branch of which will in the same manner produce other trees. The case is the same with these worms; they are cut to pieces, and each separate piece becomes a perfect animal: and each of these may be again cut into a number of pieces, each of which will in the same manner produce an animal. The reproductions of several parts of lobsters, crabs, &c. is one of the greatest curiosities in natural history. It seems indeed inconsistent with the modern system of generation, which supposes the animal to be wholly formed in the egg, that, in lieu of an organical part of an animal cut off, another should arise perfectly it: the fact, however, is too well attested to be denied.

**REPTILIA,** in Natural History, an order of Amphibia, the character of which is, that they breathe through the mouth, have feet, and flat naked ears without auricles. There are five genera; *viz.* Draco, Siren, Lacerta, Tertudo, Rana.

**REPUBLIC,** a popular state or government; or a nation where the body or only a part of the people have the government in their own hands. When the supreme power is possessed by all the body, it is called a democracy; when it is lodged in a part of the people, it is called an *aristocracy*.

**REPULSION,** in Physics, that property in bodies, whereby, if they are placed just beyond the spheres of each other's attraction of cohesion, they mutually recede and fly off. Thus, if any oily substance lighter than water, be placed upon its surface, or if a piece of iron be laid upon mercury, the surface of the fluid will be depressed about the body which is laid on it: this depression is manifestly occasioned by a repelling power in the bodies, which prevents the approach of the fluid towards them. But it is possible, in some cases, to press or force the repelling bodies into the sphere of each other's attraction; and then they will mutually tend toward each other, as when we mix oil and water till they are incorporated. Dr. Knight defines repulsion to be that cause which makes bodies mutually endeavour to recede from each other with different forces at different

# AN IMPROVED PUMP FOR DRAINING BY Mr H.W. REVELEY.



and that such a cause exists in nature, he thinks evident for the following reasons: 1. Because all bodies are electrical, or capable of being made so; and it is well known that electrical bodies both attract and repel. 2. Both attraction and repulsion are very conspicuous in all magnetical bodies. 3. Sir Isaac Newton has shewn from experience, that the surface of two convex glasses repel each other. 4. The same great philosopher has explained the elasticity of the air, by supposing its particles mutually to repel each other. 5. The particles of light are in part at least repelled from the surfaces of all bodies. 6. Lastly, it seems highly probable that the particles of light mutually repel each other, as well as the particles of air. Dr. Knight also ascribes the cause of repulsion, as well as that of attraction, to the immediate effect of God's will; and as attraction and repulsion are contraries, and consequently cannot at the same time belong to the same substance, the doctor supposes there are in nature two kinds of matter, one attracting, the other repelling; and that those particles of matter which repel each other, are subject to the general law of attraction in respect of other matter. A repellent matter being thus supposed, equally dispersed through the universe; he attempts to account for many natural phenomena by this means. He thinks light consists of this repellent matter put into violent vibrations by the repellent corpuscles which compose the atmosphere of the sun and stars; and that, therefore, we have no reason to believe they are gulfs of fire, but, like the rest of the heavenly bodies, inhabitable worlds. From the same principles he attempts to explain the nature of fire and heat, the various phenomena of the magnet, and the cause of the variation of the needle; and, indeed, it is difficult, if not impossible, by the doctrine of attraction alone, to account for all the phenomena observable in experiments made with magnets, which may be solved by admitting this doctrine of a repellent fluid; but whether it will be sufficient to account for all the particular phenomena of nature, which is the proper test of an hypothesis, time and experience alone must determine. The doctor also endeavours to shew that the attractions of cohesion, gravity, and magnetism, are the same, and that by those two active principles, *viz.* attraction and repulsion, all the phenomena of nature may be explained; but as his ingenious treatise on the subject is laid down in a series of propositions connected together, it would be impossible to do justice to his arguments without transcribing the whole: we shall therefore refer the curious reader to the book itself. According to Gravesand and others, when light is reflected from a polished spherical surface, the particles of light do not strike upon the solid parts, and so rebound from them; but are repelled from the surface at a small distance before they touch it, by a power extended over such polished surface.

REQUESTS, Court of, an ancient court of equity instituted about the nineteenth year of Henry VII.

REQUIEM, a mass sung in the Romish church for the rest of the soul of the deceased.

RESCRIPT, an answer delivered by an emperor or pope, when consulted by particular persons, on some difficult question, or point of law, to serve as a decision thereof.

RESCUE, or Rescous, is the forcibly freeing another from an arrest, or some legal commitment; which being a high offence, subjects the offender not only to an action at the suit of the party injured, but likewise to fine and imprisonment at the suit of the king.

RESERVE, Body of, or *corps de reserve*, in Military Affairs, the third or last line of an army drawn up for battle.

RESERVOIR, a large pond or enclosure of water, artificially made, in order to collect and retain it for the use of canals, mills, and occasional streams. Reservoirs are applied to various other purposes in agriculture and domestic economy.

RESIDENCE, in an ecclesiastical sense, is the continuance of a parson or vicar on his benefice.

RESIDUAL Analysis, a branch of analysis invented by Landen, and applied by him to the solution of those problems which are more generally solved by the doctrine of fluxions. This method was called the residual analysis, because in all cases where it is made use of, the conclusions are obtained by means of residual quantities. In this analysis a geometrical or physical problem is reduced to another purely algebraical; and the solution is then obtained without any supposition of motion, and without considering quantities as composed of infinitely small particles. The residual analysis proceeds by taking the difference of the same function of a variable quantity in two different states of that quantity, and expressing the relation of this difference to the difference between the two states of the said variable quantity itself. This relation being first expressed generally, is then considered in the case when the difference of the two states of the variable quantity is $= 0$.

Residual *Quantity*, in Algebra, is a binomial connected by the sign $-$; thus $a - b$; $a - \sqrt{b}$, &c. are residual quantities.

RESIDUAL Figure, in Geometry, the figure remaining after subtracting a lesser from a greater.

RESIDUE, or Residuum, that which is left after taking the part of any thing away, being much the same as remainder, the former being applied to quantity in the same sense as the latter is to number.

RESIGNATION, in the Canon Law, the surrendering a benefice into the hands of the collator, or bishop.

Resignation, or *Resignee*, in Law, the person to whom the thing is resigned.

RESIN. The name resin is used to denote solid inflammable substances, of vegetable origin, soluble in alcohol, usually affording much soot by their combustion. They are likewise soluble in oils, but not at all in water, and are more or less acted upon by the alkalis. All the resins appear to be nothing else but volatile oils, rendered concrete by their combination with oxygen. Resin, analyzed by M. M. Gay Lussac and Thenard, was found to consist of: Carbon, 75.944; hydrogen, 10·719; water, 15·156; oxygen 13·337; hydrogen in excess, 8·9. The resin of fir is known by the name of rosin. Its properties are well known. Its specific gravity is 1072. It melts readily, burns with a yellow light, throwing off much smoke. Resin is insoluble in water either hot or cold, but very soluble in alcohol.

RESISTANCE, of the fibres of solid bodies, is more properly called cohesion.

Resistance, or *Resisting Force*, in Physics, any power which acts in opposition to another, so as to destroy or diminish its effect. Resistances are of various kinds, arising from the nature and properties of the resisting bodies, the circumstance in which they are placed, and the laws by which they are governed. These may be divided into the following cases:

1. The resistance between the surfaces of contiguous solid bodies, generally denominated friction. *See* Friction and Adhesion.

2. The resistance between the contiguous particles of the same body, whether fluid or solid; for the laws of which see Cohesion and Strength.

3. The resistance that solid bodies oppose to penetration; for which see Penetration and Repulsion.

4. The resistance of elastic and non-elastic fluids to the motion of bodies moving in them. The principles of which we will endeavour to illustrate in the present article. The resistance which a body experiences from the fluid medium through which it is impelled, depends on the velocity, form, and magnitude of the body, and on the inertia and tenacity of the fluid. For fluids resist the motion of bodies through them,

1. By the inertia of their particles.
2. By their tenacity, or the adhesion of their particles.
3. By the friction of the body against the particles of the fluid.

In perfect fluids, the latter causes of resistance are very inconsiderable, and therefore are not commonly considered. But the first is always very considerable, and obtains equally in the most perfect and in the most imperfect fluids. In what follows, and in all cases of a similar description, it will be necessary to distinguish between resistance and retardation; the former being the quantity of motion, and the latter the quantity of velocity which is lost; therefore the retardations are as the resistances applied to the quantity of matter, and in the same body they have always the same constant ratio to each other. In fluids of uniform tenacity, the resistance from the cohesion of its particles is as the velocity with which the body moves. For since the cohesion of the particles is constantly the same in the same space, whatever may be the velocity, the resistance from this cohesion will be as the space described in a given time, that is, as the velocity. In a fluid whose parts yield easily without disturbing each other's motions, and which flows in behind as fast as a plane body moves forward, the resistance will be as the density of the fluid; for in this case the pressure on every part of the body is the same as if the body were at rest.

**RESOLUTION**, in Chemistry, &c. the reduction of a mixed body into its component parts, or first principles, by a proper analysis.

Resolution, in a general sense, denotes the dividing or separating any compound quantity or thing into its original component parts.

Resolution of *Equations*, in Algebra, is the determination of the values of the unknown letters or quantities of which the equation is composed; in order to which, it is necessary first to exterminate or eliminate all the unknown quantities but one of the equation, and then the value of the remaining quantity is to be found by the proper rules for this purpose, *viz.* by the rules given for simple, quadratic, cubic, or biquadratic equations, according to which of these it may belong; or by the general method of approximation; for which see the respective articles.

Resolution of *Motions* and *Forces*. *See* Parallelogram of *Forces*.

**RESPIRATION**, is the act of receiving a portion of air into the lungs, and again emitting it. The blood of the veins is charged with a portion of carbon which it emits in the lungs, and this carbon uniting with the oxygen received in the lungs, forms carbonic acid gas, and is emitted, as is also the nitrogen or azote. The volume of carbonic acid discharged is exactly equal in bulk to the oxygen which has disappeared, and it is hence supposed that no oxygen is absorbed by the lungs; but other philosophers have been of a contrary opinion, and have supposed that the change of the colour of purple of the venous blood into red, in the arterial blood, which takes place on passing through the lungs, was attributable to the absorption of oxygen, whilst, on the other hand, this has been attributed solely to the discharge of the carbon. An ordinary sized man consumes about 46,000 cubic inches of oxygen per day, and makes 20 respirations in a minute. The quantity of carbonic acid formed during respiration is diminished after swallowing intoxicating liquors, or under a course of mercury, nitric acid, or vegetable diet.

**RESPITE**, in Lsw, &c. a delay, forbearance, or prolongation of time, granted to any one for the payment of a debt. In criminal cases, it is the suspension of a sentence, as to the time of its being executed. In knight service, it is the dispensing with the homage of a vassal, on certain conditions, and during a given time.

**REST**, in Physics, the continuance of a body in the same place, either absolutely or relatively, *viz.* its continuance in the same part of absolute space, or in the same part of relative space; and is hence denominated absolute or relative rest. It is, however, highly probable, that in its most extensive sense there is no such thing as absolute rest in the whole creation, at least we know of nothing in such a state.

**RESTING Ground**, the omission of crops for a given period, that the soil may recover its primitive fertility, which constant tillage tends to impoverish.

**RESTITUTION**, in Physics, the returning of elastic bodies, forcibly bent, to their natural state. In a moral sense, restitution, reinstates a person in his rights, or restores something that had been unjustly taken from him. In law, it is a returning of stolen goods.

**RESULTANT**, in Mechanics, is used to denote that single force, or the line represent the quantity and direction of that single force, which is equivalent to two or more forces whose quantities and directions are given.

**RETAINER**, in Law, a servant who does not continually dwell in the house of his master, but only attends upon special occasions.

**RETAINING Fee**, the first fee given to a sergeant or counsellor at law, in order to make him sure, and prevent his pleading on the contrary side.

**RETALIATION**, the act of returning like for like. It is excited by aggression, and frequently leads to civil wars.

**RETARDATION**, any force tending to diminish the velocity of moving bodies.

Retardation may arise either from the effect of resistance, or from the action of gravity. For that which arises from the former, and for the distinction between resistance and retardation, see Resistance.

Retardation, from Gravity, is peculiar to bodies projected upwards, which have their velocities diminished, by precisely the same laws as falling bodies have theirs accelerated. Thus, if a body be projected perpendicularly upwards, with a velocity which would, independently of gravity, cause it to ascend $a$ feet per second; it will, in consequence of the action of gravity, have its velocity so diminished, that, at the end of the first second, it will be only $(a-32)$ feet, or at the end of the second it will be only $(a-64)$ feet, &c. Hence, to find the greatest height to which a body will ascend when projected perpendicularly upwards with any given velocity, the time of ascent, &c. it is only necessary to find the space through which a body must fall to generate that velocity, and the time it would be in descending through that space, which will be precisely the same as the height through which it will ascend, and the time of its ascent. *See* Acceleration.

**RETCHING**, in Sickness, an effort or endeavour to vomit.

**RETENEGE**, in the Materia Medica, a name used to express the common resin of the pine or fir tree, and sometimes common black pitch.

**RETENTION**, is defined, by Locke, to be a faculty of the mind, whereby it keeps or retains those simple ideas it has once received by sensation or reflection.

Retention, is also used, in medicine, &c. for the sate of contraction in the solids or vascular parts of the body, which makes them hold fast their proper contents.

**RETI**, in Hindoo Mythology, is a personification of affection, and the fabled consort of Kama the god of love.

**RETICULA**, or Reticule, the name of an instrument formerly employed for measuring the number of digits eclipsed in either luminary; its construction depends on nearly the same principles as that of the Micrometer.

**RETINA**, in Anatomy, a membrane of the eye, formed by an expansion of the optic nerve, and constituting the immediate organ of vision. *See* Eye.

**RETINASPHALTUM**, in Mineralogy, a name given to an inflammable kind of resinous substance accompanying Bovey coal. On the first application of heat, it melts and smokes, and then burns with a bright flame.

**RETINUE**, the attendants or followers of a prince or person of quality, chiefly on a journey.

**RETIRED List**, a list on the marine establishment, on which superannuated officers are placed. Officers on the retired list of the East India service, have several advantages over others.

**RETORT**, in Chemistry, is a kind of round-bellied vessel, made of earth, glass, or metal, having a crooked neck or beak to which the recipient is fastened. Retorts are of essential service in distillations, and most frequently for those which require a degree of heat superior to that of boiling water.

**RETRAXIT**, in Law, is where the plaintiff comes into court in person, either alone or with the defendant, and declares he will proceed no further in his action. When this is done the same action can never be renewed.

**RETREAT**, in Gardening, is an erection or arbour, a nook or recess, formed either for pleasure or convenience. In its formation, utility and beauty should go hand in hand.

Retreat, the order or disposition in which a fleet or squadron declines engagement, or flies from a pursuing enemy.

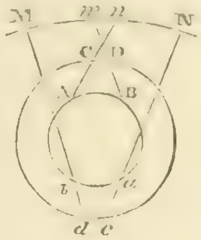
Retreat, in War, is the retiring or retrograde motion of an army from its former position. The skill of a commander is generally more conspicuous in his retreats than in his advances and engagements. The retreat of the ten thousand Greeks under Xenophon has been the subject of universal admiration. The most remarkable retreats in modern times have been that of Moreau in 1796, through Swabia; that of Macdonald in Italy; and that of Sir John Moore in Spain, in 1809-1810.

**RETRENCHMENT**, in the art of War, any kind of work, raised to cover a post, and fortify it against the enemy.

**RETROACTIVE**, in Law, that which has an operation or influence on time and transactions that are past.

**RETROGRADATION**, or Retrogression, in Astronomy, is an apparent motion of the planets, by which they seem to move backward in the ecliptic, or in *antecedentia*, or contrary to the order of the signs. When a planet moves in consequentia, or according to the order of the signs Aries, Taurus, Gemini, &c. it is said to be *direct*. When it appears for a few successive days in the same place or point of the heavens, it is said to be *stationary*. And when it goes in antecedentia, or contrary to the order of the signs, it is said to be retrograde.

Both the superior and inferior planets are subject to this apparent irregularity in their motions; but it arises from different causes, as may be illustrated as follows:—Let C D *c d* represent the orbit of the earth, and A B *a b* that of any inferior planet, as Venus; now when the earth is at *c*, and Venus at A, the former being moving towards *d* with a less velocity than the latter is towards B, it is obvious, that the apparent motion of Venus, as referred to the heavens M N, will be from M towards N, or according to the order of the signs. But if, when the Earth is at *c*, Venus is at *a*, then her apparent place in the heavens will be at N; and when the Earth is arrived at *d*, Venus will have come to *b*, and her apparent place in the heavens will be at M, and consequently during this time she will appear to be moving in the heavens from N to M, *viz.* contrary to her former motion, which motion being in antecedentia, or contrary to the order of the signs, is then said to be retrograde. Whence it appears that when an inferior planet is in, or nearly in its superior conjunction, its apparent motion is direct, but when in its inferior conjunction, its apparent motion is retrograde, and for a few days between these two she has no apparent motion, and is therefore said to be stationary.



With regard to the superior planets, it is obvious that their retrogradation must happen when they are in opposition; thus, if we now suppose A B *a b* to be the orbit of the earth, and C D *c d* that of Saturn, and suppose that when the latter is at C, the former is at A, then the apparent place of Saturn in the heavens will be at *n*; but the motion of the Earth exceeding that of Saturn, when we are arrived at B, he will only be got to D, and his apparent place will be at *m*; and therefore during this tnterval his apparent motion will be retrograde. Whereas it is obvious that had the earth been at *a*, instead of being at A, as we have supposed above, that is, if Saturn had been in conjunction, its apparent motion in the heavens must have been contrary to the former, or in consequentia, or according to the order of the signs; and for a time between these two motions he must necessarily have appeared stationary, as is obvious without any particular illustration. The periods of retrogradadation of the several planets are not aways the same, but at a mean they are nearly as follows:—Saturn 140 days, Jupiter 120 days, Mars 73 days, Venus 42 days, and Mercury 22 days.

**RETROCESSION** of the *Equinoxes*. *See* PRECESSION.

**REVE**, REEVE, or *Greve*, the bailiff of a franchise, or manor, thus called, especially in the west of England.

**REVEILLE**, a beat of drum about break of day, to give notice that it is time for the soldiers to arise, and that the sentries are to forbear challenging.

**REVELS**, entertainments of dancing, masking, acting comedies, farces, &c.

**REVENUE**, PUPLIC, the portion of the general income of a state, which is appropriated to the payment of national expenses. The ordinary revenue of the early kings of England consisted of the following branches:

1. Rents and profits of the crown-lands.

2. Profits from military tenures. As a great part of the lands in England were subject to knight-service, the profits incident to this tenure were very great, besides the extraordinary contributions to which they were liable, for making the king's son a knight, and for marrying his eldest daughter.

3. The custody of the lay revenues, with the lands and tenements of bishoprics during their vacancy.

4. First-fruits, and tenths of all spiritual preferments. These revenues are now vested in trustees for ever, as a fund for the augmentation of poor livings, and form what is usually called Queen Ann's Bounty.

5. Purveyance and pre-emption, or a right of buying up provisions and other necessaries, for the use of the royal household, at an appraised valuation, in preference to all other persons, and even without the consent of the owner; also of forcibly impressing carriages and horses for the king's use at a settled price, The purveyors greatly abused their authority, and were of little advantage to the crown; Charles II. therefore at his restoration, agreed to resign this prerogative, with the military tenures; and the Parliament, in lieu thereof, settled on him and his successors for ever a tax on beer and ale, afterwards commonly called the hereditary excise.

6. Fines and forfeitures of various descriptions; also fees to the crown in a variety of legal matters.

7. The right to all shipwrecks; to treasure-trove; to royal fish, that is, whales and sturgeons, when thrown ashore, or caught near the coast; to all mines of silver or gold; to waifs or goods stolen and thrown away by the thief in his flight; and estrays, or animals found wandering, and the owner unknown; and to deodands and forfeitures of lands and goods for offences. These rights, producing little profit, have since been mostly granted away to the lords of manors and other liberties.

8. Escheats of lands upon the defect of heirs to succeed to the inheritance, in which case they reverted to the king.

9. The custody of idiots and lunatics, the profits of whose lands were received by the king, an allowance being made to them for necessaries.

From these sources, the produce of the remaining branches of which is now very insignificant, the kings of England derived the whole of their ordinary revenue, till commerce raised the produce of the customs into importance, and the parliament ventured to grant the principal part of their produce to the king, for life. Upon extraordinary occasions, Henry II. and some of his successors, had recourse chiefly to scutages, which were a composition of those who held knights' fees, in lieu of the military service to which they were bound, as the king and the persons liable could agree: hydage and talliage were taxes of the same nature, upon other lands and upon other cities and boroughs. Tenths and fifteenths were originally the real tenth or fifteenth of all the moveables belonging to the subject; the amount was uncertain, being levied by new assessments on every fresh grant, till the 8th Edward III. when a new assessment was made and recorded in the exchequer, which was the real value at that period of every city, borough, and town in the kingdom, and by this the fifteenths were afterwards levied according to the specific sums therein stated, which were usually raised in different places by a common rate on all the inhabitants. Subsidies were a grant introduced about the time of Richard II. and Henry IV. This mode of taxation fell into disuse during the civil wars in the reign of Charles I. when the parliament introduced weekly and monthly assessments, at a fixed sum upon each county, which was levied by a pound rate both upon land and personal estates. The commonwealth afterward introduced excise duties, and derived some profit from the establishment of the post office, both of which have been since improved into very productive sources of revenue.

The various duties now constituting the total public revenue of Great Britain, are arranged under the following heads:

1. The Custom, which consist of duties on goods imported, on goods exported, on goods carried coastways, and a tonnage duty.

2. The Excise, which consists principally of duties on malt liquors of every kind, including the distillery; many other articles are, however, likewise included, as candles, leather, soap, starch, tea, coffee, wine, tobacco, salt, glass, printed goods, and bricks and tiles.

3. Stamp Duties, laid on deeds and documents of almost every description.

4. Land and Assessed Taxes. In 1799 a scheme was adopted for the redemption of the land tax, for which purpose an act was passed, making the tax perpetual; it was then offered for sale to the proprietors of the lands upon which it was charged, or, if they declined it, to any other persons who chose to become a purchaser. The consideration to be given in either case was not to be in money, but in the three per cent. stock: the object of the scheme being to absorb a large quantity of floating stock, and thus facilitate the raising of new loans. It

was estimated that this measure would transfer about eighty millions of stock to government, but the terms offered were by no means such as to induce a general approval of it, and the total amount of stock transferred for land-tax redeemed on the first of February, 1808, was only 22,976,829*l.* 10*s.* 4*d.* of course a very considerable portion of the tax still remained unredeemed. The assessed taxes consist of the duties on houses, windows, servants, carriages, horses, and horse-dealers, dogs, hair powder, and armorial bearings.

5. The Post Office. King James I. originally erected a post office for the conveyance of letters to foreign parts, previously to which an establishment of this kind had existed for the conveyance of inland letters.

6. Sixpence in the pound on pensions and salaries.

7. One shilling in the pound on pensions and salaries.

8. Hackney coaches.

9. Hawkers and pedlars.

In addition to these several branches of the public revenue, there are some small branches of the old hereditary revenue still remaining. These consist chiefly of alternation fines, post fines, seizures of uncustomed and prohibited goods, compositions, profers and the crown lands, of which the last is by far the most important.—*Watkins's Cyclopædia.*

**REVERBERATION**, in Physics, the act of a body repelling or reflecting another after its impinging on it. Hence, *echoes* are occasioned by the reverberation of sounds from arched obstacles. In glass furnaces the flame reverberates, or bends back again, to burn the matter on all sides. In Chemistry, reverberation denotes a circulation of flame, or its return from the top to the bottom of the furnace, when calcination is required.

**REVERENCE**, in Ethics, is the veneration or high degree of respect which is paid to superior sanctity, by a conscious inferiority of moral worth.

**REVERSE**, of a medal, coin, &c. denotes the second or back side in opposition to the head or principal figure.

**REVERSED**, in Heraldry, a thing turned backwards or upside-down.

**REVERSION**, a sum of money, estate, annuity, or any other kind of property, the possession of which is not to be obtained till after the expiration of a certain period of time, or till some event, as the failure of a life or lives has happened. The present value of such property depends greatly on the current interest of money, for if money produced only three per cent. interest, a person giving 1000*l.* for a reversionary estate relinquishes an annuity of 30*l.* but if he could make five per cent. interest of his money, he gives up an annuity of 50*l.* and consequently in the latter case he would expect a greater reversion than the former. The true value of a reversion therefore is that present sum which, if improved at a given rate of interest, would, at the period when the reversion comes into possession, amount to its then actual value. This, with respect to sums receivable at the end of a certain number of years, is easily found by the Table of INTEREST. Thus, if a person is entitled to 500*l.* at the end of ten years, and wishes to know its present worth: the value of one pound to be received at the end of this term, is, by the Table, 613913, which multiplied by 500, gives 326*l.* 19*s.* 1*d.* for the present value of the reversion.

**REVERSION of SERIES**, in Algebra, is the method of finding the value of the root or unknown quantity, whose powers enter the terms of a finite or infinite series, by means of another series in which it does not enter.

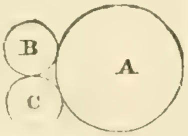
**REVERSING of MOTIONS**, *Contrivances for.* We shall here mention some methods of reversing motions after long intervals; as is the case of drawing up buckets from wells or mines, where no change of direction may be required for several minutes; or in different kinds of mill work, where the direction may not be changed for some hours.

Contrivances to effect such reversion of motion are very numerous; but almost all of them may be reduced to two general methods; for the required change is generally produced either by making two equal pinions on one and the same axis, taken alternately into the teeth of those parts of a larger wheel which are nearly diametrically opposite; or, by means of an additional wheel, which may, as the practical mechanics term it, be thrown in and out of gear alternately. In many engines for drawing buckets out of mines that are moved by horses, the motion is frequently reversed by turning round the animal, and causing him to retrace his steps and draw the contrary way; but this is found very injurious to the horse, a circumstance which has frequently led to the adoption of other methods. In Emerson's Mechanics, a simple contrivance is described, consisting merely of a horizontal face wheel, upon the same vertical shaft as the horse-pole is attached to, and two equal pinions upon the same axle as carries the drum or barrel on which the rope winds. The axle which carries the drum and pinions is fixed horizontally, a little above a diameter of the face wheel; and first one, and then the other, of the pinions is made to be driven by that wheel; thus, manifestly, reversing the motion as required. There are two methods of attaching these pinions to the axle, and making them to be acted upon by the face-wheel: in one of them, the pinions are fastened upon the axle, at a distance from each other exceeding the diameter of the face wheel only three or four inches; then, the axle being moved horizontally through this small distance, brings first one and then the other pinion into contact with the wheel at opposite extremities of a diameter, and thus changes the direction of the motion; but this method is attended with the disadvantage of having often to move a heavy weight with the horizontal axle, besides that there is much danger of breaking the teeth of the pinions and wheel when they first come to embrace each other. In the second method, the lanterns or pinions both turn constantly with the face wheel, but they play freely upon their common axle, except that they are stopped by a pin which *fixes* them; the application of such pin to first the one, and then the other, of the lanterns, produces the alternating motion as proposed.

M. Prony has two contrivances for reversing the motion in horse-whims, without changing that of the animal: in both of which, however, the general principle is the same as that adopted by Emerson. In the first, a horizontal wheel, toothed at its face, lay just above two vertical pinions, fixed on the opposite extremities of an axis of the length of its diameter. This wheel was so contrived as to incline a little from its horizontal position to either side at pleasure; so that on the one inclination, its teeth locked with those of one pinion, and receded from the other; and on the other position, its operation on the pinions was reversed; by which, the axis of the pinions turned round first in one direction, and afterwards in the contrary. Prony, finding this method subject to some inconveniences, contrived the following, which he esteems much superior to it. A horizontal wheel, toothed at its face, and attached to a perpendicular arbor, (which gives it motion,) turns two pinions, moveable on the same axis, which it meets at the opposite sides of its circumference: these pinions are not attached to the axis, but turn round freely upon it: the intermediate part of the axis is square, and has, adjoining to each pinion, boxes which slide back and forwards on it, each of which support a faced wheel, with strong serrated teeth; the serration being in a different direction on the opposite wheels: the boxes are connected by two iron bars, so as to change their places by one movement; to the pinions there are also serrated faced wheels attached, so as to lock on those opposite to them on the sliding boxes. From this construction it follows, that when the boxes are slidden to one extremity of the axis, the pinion at that side will be connected with the axle, and communicate its motion to it in one direction; and when the boxes are moved to the other extremity, then the first pinion will be disengaged, and the second be locked to the axle, and cause it to turn round in a direction the reverse of that in which it moved before. There is a lever on another axle, whose office is to move the before-mentioned boxes backwards and forwards; an arm projects from the axis, which moves between two pieces, proceeding from the frame connected with the boxes; the lever rises upwards, and has a weight at its top, by which it presses strongly in either direction, when it passes the perpendicular position; forming thus the contrivance vulgarly called a tumbling bob, which is used in various engines for a similar purpose. Upon the same axle on which the pinions move is fastened a drum wheel, round which passes the chain or cord to which the buckets are attached; another chain or cord is placed below the buckets, from the bottom of one to that of the other, to form an equilibrium between the whole of the appendage of one bucket and that of the other in all positions. A bar is so placed, that, on one of the buckets rising to a certain height, it catches the bar, forces it upwards, and thereby throws over the tumbling bob connected with its other extremity: this reverses the movement of the buckets; and, on the other bucket rising, it operates in the same way on another lever, which throws the bob to the other side, and causes the first bucket to rise again.

Prony has annexed a contrivance to this engine, by which the horse that puts it in motion is disengaged, when any accident happens which would tend to stop the movement of the wheels: for this purpose, the traces pass under two pulleys in the ends of the yoke; and their extremities, which have loops wrought in them, are alternately attached to two pins in a roller, round which a cord is wound two or three turns, and passes from thence through rings in the lever, (which causes the arbor to revolve,) and over a pulley on the arbor to a weight which hangs beside it. When the draught exceeds this weight, it is evident the roller will be drawn round by the traces, and that they will slip off the pins, and be disengaged during the first revolution.

The method of reversing motion by causing pinions to be operated upon by the opposite parts of a face-wheel, has been long known and practised by millwrights; and they have various contrivances for performing the alternation, as by levers, screws, tumbling bobs, &c. One of these will be illustrated by a figure, when we come to the article Tide *Mill*.



As to the second general method, it has, perhaps, an appearance of greater simplicity; though, when reduced to practice, it is commonly found more expensive than the former. Suppose, that while the horizontal wheel A, in the annexed figure, continues to turn always one way, it is required to have the horizontal wheel B turn, sometimes in one direction, and sometimes in another: by means of an additional wheel C, equal in diameter and number of teeth, (supposing the velocities in both directions to be equal,) this may be accomplished, thus:—Let the two wheels B and C have the lower pivots of their axles resting in boxes or cases that may be moved up and down by means of screws; and, while the wheels A and B are nearly of equal thickness, let the wheel C be somewhat more than double the thickness of either: when the motion of the wheel B is to be in a contrary direction to that of A, let the wheel C be lowered so much that its teeth play neither into those of A nor B, while the teeth of A take into those of B, and drive it round; when, on the contrary, B is to be moved in the same direction as A, let the wheel B be lowered till its teeth do not come into contact with those of A, and let C be raised until the upper parts of its teeth take between those of the wheel A, while the lower parts of the other teeth play into the teeth B; so shall the rotation of B have the direction required. If the motion of the wheel A were sometimes in one direction, and sometimes in another, the motion of B might, all along, be preserved in one direction, by the occasional application of C as an intermediate wheel.

**REVIEW**, in Chancery, is used for a bill where a cause has been heard, and a decree thereon signed; but some error in law appearing upon the decree, or new matter being discovered after it was made, this bill is given for a fresh examination into the merits of the cause.

Review, in War, is the appearance of an army, or part of an army, in order of battle, and their being viewed by the general, that he may know the condition of the troops.

Review, is also the name of one kind of periodical publications, now too much prostituted (under the shelter of anonymous criticism) to the purposes of the malice of rival authors, and the petty artifice of interested booksellers.

**REVISE**, among Printers, a second or third proof of a sheet to be printed; taken off in order to be compared with the last proof, to see whether all the mistakes marked in it are actually corrected.

**REVIVOR, Bill of**, in Chancery, is a bill for reviving a cause, where either of the parties dies after the bill and answer, and before the cause is heard; or if heard, before the decree is inrolled; in which case the bill must be brought, praying that the former proceedings may stand revived, and be put on the same footing as at the time of the abatement.

**REVOCATION**, in Law, signifies the recalling, or anulling and making void, some power, grant, deed, &c. made before.

**REVOLUTION**, the motion of a body or line about a centre which remains fixed.

*Period* of Revolution, in Astronomy, is the time a planet, comet, &c. employs in passing from any point in its orbit to the same point again. This, with regard to the earth, is what determines the length of the year. *See* Year. And for the times of revolution of the other planets, *see* Period and Planet.

**REYNEAU, Charles Rene**, a reputable French mathematician, was born in 1650 at Brissac, in Anjou. He taught philosophy at Pezenas and Toulon; and in 1683 was appointed to the mathematical professorship at Angers, where he died in 1728, at the age of 78 years.

**RHABDOLOGY**, a name given by Napier to his method of performing multiplication, division, &c. by means of small bones or rods. *See* Napier's Rods.

**RHAPSODI**, in Antiquity, persons who made a business of singing or reciting pieces of Homer's poems. Cuper says, that the rhapsodi were clothed in red when they sung the Iliad, and in blue when they sung the Odyssey.

**RHAPSODOMANCY**, an ancient kind of divination, performed by fixing on a passage of some poet at hazard, and then reckoning on it as a prediction of what should come to pass.

**RHEA Americana**, the American ostrich, in size is very little inferior to the common one; the bill is sloped not unlike that of a goose, being flat at the top and rounded at the end; the eyes are black, and the lids furnished with hairs; the head is rounded, and covered with downy feathers; the neck is two feet eight inches long, and feathered also; from the tip of one wing to that of the other extended, the length is eight feet; it cannot fly, but it runs very swiftly; the legs are stout, and bare of feathers above the knees, and furnished with three toes, all placed forwards, each having a straight and stout claw as in the cassowary; on the heel is a callous knob serving in the place of a back toe; the general colour of the plumage is dull gray mixed with white, inclining to the latter on the under parts; the tail is very short, and not conspicuous, being entirely covered with long loose and floating feathers, having its origin from the lower part of the back and rump, and entirely covering it; the bill and legs are brown.

**RHETICUS, George Joachim**, a distinguished German astronomer, and mathematician, was born at Feldkirk in the Tyrol, in 1514, and for some years assisted the celebrated Copernicus in his astronomical labours. He died in 1576, near 63 years of age.

**RHETORIC**, in the most extensive sense of the word, denotes the art of composition, or that which enables us to apply language or speech to the best possible advantage. According to etymology, which often affords the most satisfactory explanation of words, it signifies the art of pouring forth a stream of sentiment, and communicating with fluency our feeling and thoughts to others. Taken in this point of view, rhetoric will comprehend all polite literature, poetry perhaps excepted, the belles-lettres of the French, the pathetic and pleasant of every kind; compositions whose aim and end is not so much to inform or satisfy the understanding, as to move, incline, and persuade, by addressing the imagination, the affections, and in some measure sensation itself. There cannot be a better rule for composition, and one more plain and practical, than what is laid down by Cicero: "We are first to consider what is to be said; secondly, how; thirdly, in what words; and lastly, how it is to be ornamented." See the Editor's Grammar of Rhetoric and Polite Literature, Dr. Hugh Blair's "Rhetoric," Dr. Campbell's Philosophy of Rhetoric, &c.

**RHEUM, Rhubarb**, a genus of the monogynia order in the enneandria class of plants, and in the natural method ranking under the 12th order, holoraceæ. There is no calyx; the corolla is sexfid and persistent; and there is one triquetrous seed. There are seven species.

**RHEUMATISM**, a well-known painful distemper, coming, as is supposed, from acrid humours.

**RHINOCEROS**, in Natural History, a genus of mammalia of the order Feræ. Generic character; horn solid, perennial, conical, seated on the nose, but not adhering to the bone. This quadruped is exceeded in size only by the elephant. Its usual length, not including the tail, is twelve feet; and the circumference of its body nearly the same. Its nose is armed with a horny substance, projecting, in the full-grown animal, nearly three feet, and is a weapon of defence, which almost secures it from every attack. Even the tiger, with all his ferocity, is but very rarely daring enough to assail the rhinoceros. Its upper lip is of considerable length and pliability, acting like a species of snout, which, grasping the shoots of trees and various substances, conveys them to the mouth, and it is capable of extension and contraction at the animal's convenience. The skin is, in some parts so thick and hard as scarcely to be penetrable by the sharpest sabre, or even by a musket ball. These animals are found in Bengal, Siam, China, and in several countries of Africa, but are far less numerous than the elephant, and of sequestered solitary habits. The female produces only one at a birth; and at the age of two years the horn is only an inch long, and at six only of the length of nine inches. It is generally, however, quiet and inoffensive. Its food consists entirely of vegetables, the tender branches of trees, and succulent herbage, of which it will devour immense quantities. It delights in retired and cool situations, near lakes and streams, and appears to derive one of the highest satisfactions from the practice of rolling and wallowing in mud; in this respect bearing a striking resemblance to the hog.

This animal was exhibited by Augustus to the Romans, and is supposed to be the unicorn of the scripture, as it possesses the properties ascribed to that animal, of magnitude, strength, and swiftness, in addition to that peculiarity of a single horn, which may be considered as establishing their identity. The two-horned rhinoceros, is similar in size and manners to the former, and is principally distinguished from it by having two horns on its nose; the first being always the largest.

**RHINOCEROS AVIS**, in Ornithology, a name given to a species of Indian raven, the beak of which being remarkably fine, and having a horn-like protuberance on its upper part, is frequently brought to Europe. It is an ugly bird, has a very rank smell, is larger than the English raven, and feeds on carrion.

**RHINOMACER**, a genus of insects, of the order coleoptera.

**RHODIUM**, a new metal discovered among the grains of crude platina by Dr. Wollaston.

**RHODORA**, (*Canadian Rose-blossom*,) a genus of the decandria monogynia class and order.

**RHOMBOIDES**, in Geometry, a quadrilateral figure, whose opposite sides and angles are equal, but which is neither equilateral nor equiangular; or it is an oblique angled parallelogram.

**RHOMBOIDIA**, the name of a genus of spars, given them from their being of a rhomboidal form. They derive this figure from an admixture of particles of iron, and consist of six planes.

**RHOMBUS**, in Geometry, an equilateral rhomboid, or a quadrilateral figure, whose sides are equal and parallel, but the angles unequal; the two opposite ones being obtuse, and the other two acute.

**RHUBARB.** *See* RHEUM.

**RHUMB**, in Navigation, a vertical circle of any given place, or the intersection of such a circle with the horizon, in which last sense the rhumb is the same with the point of the compass.

**RHUMB LINE**, or *Loxodromia*, in Navigation, is a line prolonged from any point in a sea chart, except in the direction of any of the four cardinal points; or it is the line described by a ship while her course is constantly directed towards one and the same point of the compass, except the four above mentioned, that is, while she crosses all the meridians at the same angle, providing this is not a right one, and this angle is called the angle of the rhumb; and that which it makes with the equator, or a parallel to the equator, is called the complement of the rhumb. If a vessel sail either north or south, it evidently describes a great circle of the sphere, or part of such a circle; and if her course is either due east or due west, she cuts all the meridians at right angles. But if her course is oblique to these principal points, then she no longer describes a circle, but a sort of spiral, the characteristic property of which is, that it cuts all the meridians at the same angle, and is thence denominated the loxodromia, or loxodromic curve, or rhumb line, which, though it continually approaches towards the pole, can never arrive at it, except after an infinite number of revolutions.

**RHYME.** *See* POETRY.

**RHYTHMICAL**, in Music, an epithet applied to the property, or quality, in the ancient melopœia, and modern melody, by which the cadences, accents, and quantities, are regulated and determined.

**RIBAND**, or RIBBON, a narrow sort of silk, chiefly used for head ornaments, badges of chivalry, &c.

**RIBANDS**, in Naval Architecture, long, narrow, flexible pieces of timber, nailed upon the outside of the ribs from the stem to the stern-post, so as to encompass the ship lengthways; of these the principal are the,

*Floor* RIBAND, which terminates at the height of the rising line of the floor; and the

*Breadth* RIBAND, which coincides with the wing transom, at the height of the lower-deck: all the rest are termed intermediate ribands.

The ribbands being judiciously arranged with regard to their height and distance from each other, and forming regular sweeps round the ship's body, will compose a kind of frame, whose interior surface will determine the curve of all the intermediate or filling timbers, which are stationed between the principal ones. As the figure of a ship's body approaches to that of a conoid, and the ribands having a limited breadth, it is apparent that they cannot be applied to this convex surface without forming a double curve, which will be partly vertical and partly horizontal, so that the vertical curve will increase by approaching the stem, and still more by drawing near the stern post. It is also evident, that by deviating from the middle line of the ship's length, as they approach the extreme breadth at the midship frame, the ribands will also form a horizontal curve. From this double curve it results that the ribands will appear in different points of view when delineated on different planes of the same ship.

**RIBES**, the currant and gooseberry bush, a genus of the monogynia order in the pentandria class of plants, and in the natural method ranking under the 36th order, pomaceæ.

**RIBS** *of a Parrel*, are short pieces of plank, each having two holes in it, through which the two parts of the parrel-rope are received, the inner smooth edge of the rib resting against and sliding readily up and down the mast.

**RICCIOLI**, JOANNES BAPTISTA, a learned Italian astronomer and mathematician, was born at Ferrara, a city in the papal dominions, in 1598, and died in 1671, in the 73d year of his age.

**RICHERIA**, a genus of the class and order diœcia pentandria; a tree of great size.

**RICINUS**, or PALMA CHRISTI, a genus of the monadelphia order, in the monœcia class of plants, and in the natural method ranking under the 38th order, tricoccæ.

**RICKETS**, a disease affecting children, and principally characterized by enlargement and inflexure, or distortion of the bones.

**RICOCHET** FIRING, in the Military art, is a method of firing with pieces elevated from three to six degrees, and loaded with a small charge, so that the ball may bound and roll along inside the parapet. The ball or shot thus discharged, goes bounding or rolling, killing or maiming all it meets with in its course, and creates much greater disorder, by thus moving slowly, than if thrown from the piece whose elevation is greater, with much greater violence.

**RIDDLE**, in rural economy, a sort of sieve, used to separate the grain from dust, and the seeds of weeds. In Mineralogy, the riddle is used to separate the ore from surrounding rubbish.

**RIDE** (*To*) *Head to Wind*, is when the wind is so much more powerful than the tide, as to cause the ship to swing till her head is in the direction of the former.

*To Ride Athwart*, or *between Wind and Tide*, is when the wind and tide are in opposition, but so nearly equal in their force, that the ship rides with the tide running against one side, and the wind blowing upon the other.

To RIDE *out a Gale*, signifies that the ship does not drive during the storm.

To RIDE *Easy*, is said of a ship when she does not labour or feel a great strain upon her cables.

To RIDE *Hard*, is, on the contrary, to pitch violently in the sea, so as to strain her cables, masts, or hull.

To RIDE *a Head-rope of a Sail*, &c. is to shake and stretch it by treading upon it while a purchase is employed at the end to extend it. A rope is said to ride when one of the turns by which it is wound round lies over another, so as to interrupt the operation, or prevent its rendering.

RIDERS, a sort of interior ribs, fixed occasionally in a ship's hold, opposite to some of the principal timbers to which they are bolted, and reaching from the keelson to the beams of the lower-deck, and sometimes higher, in order to strengthen her frame. They are bolted to the other timbers to support them when it is apprehended the ship is not sufficiently strong in the part where they are fixed, which is generally a-midships. They have also their floor pieces and futtocks, and sometimes their top pieces, and being scarfed to each other in the same manner as the timbers, they have similar distinctive appellations, as the Rider *Futtocks*; *Lower Futtock* Riders; *Middle Futtock* Riders; *Upper Futtock* Riders; *Floor* Riders. See the article Floor. The riders ought to be stationed so as to lie between two ports of the lower deck, and to correspond with the timbers to which they are attached, in such manner as that the scarfs of the riders may be clear of the timbers. They are scored upon the keelson, clamps, and thick stuff of the bottom. They are secured by bolts, which are driven from without, so as to penetrate the outside planks, the timbers, the clamps, and the riders, on the inside of which last they are fore-locked. These pieces are rarely used in merchant-ships, on account of the space they occupy in the hold; neither are they generally used in vessels of war, at least, till the ship is enfeebled by service.

RIDGE, a long narrow assemblage of rocks, lying near the surface of the sea.

RIDGES, in Agriculture, are pieces of ground laid up between two furrows, having always considerable length, but of small breadths.

RIDING, a corruption of *Trithing*, now chiefly used as divisions of Yorkshire, of which there are three.

Riding *Clerk*, one of the six clerks in chancery, who, in his turn annually keeps the controlment books of all grants that pass the great seal that year.

RIFLE, a firm-arm which has the inside of its barrel cut with from three to nine or ten spiral grooves, so as to make it resemble a female screw, varying from a common screw only in this, that its grooves or rifles are less deflected and approach more to a right line; it being now usual for the grooves with which the best rifled barrels are cut, to take about one whole turn in a length of thirty inches. The number of these grooves differ according to the size of the barrel and the fancy of the workman; and their depth and width are not regulated by any invariable rule.

RIG, *To*, is to fit the shrouds, stays, braces, &c. to their respective masts and yards.

To Rig *in a Boom*, is to draw it in from a situation upon the end of a yard, bowsprit, or another boom, &c. to extend the foot of a sail.

RIGGERS, men who make a livelihood by going on board ships to fit the standing and running rigging. It is also a name given in the navy to any party of men sent to the rigging loft or hulk, to prepare the standing rigging for putting over the mast-heads.

RIGGING, a general name given to all the ropes employed to support the masts, and to extend or reduce the sails, or arrange them to the disposition of the wind.

*Standing* Rigging, is that which is used to sustain the masts, and remains in a fixed position; as the shrouds, stays, and back-stays.

*Running* Rigging, is that which is fitted to arrange the sails, by passing through various blocks in different places about the masts, yards, shrouds, &c. as the braces, sheets, halliards, clew-lines, &c. &c.

*Lower* Rigging, is that which attaches to the lower masts.

*Top-Mast* Rigging, consists of the top-mast shrouds, stays, and back-stays.

Rigging-*Loft*, a kind of long room or gallery in a dock yard, where the standing riging is fitted by stretching, serving, splicing, seizing, &c. to be in readiness for the ship.

RIGHT, in Geometry, signifies the same with straight; thus a straight line is called a right one.

Right, in Law, not only denotes property, for which a writ of right lies, but also any title or claim, either by virtue of a condition, mortgage, &c. for which no action is given by law, but an entry only.

Right Angle, *Cone*, *Cylinder*, *Sphere*, &c. See their respective substantives.

RIGHTING, the act of restoring a ship to her upright position after she has been laid upon a careen, which is effected by casting loose the careening tackles, and, if necessary, heaving upon the relieving-tackles.

A ship is also said to right at sea, when she rises with her masts erect, after having been pressed down on one side by the effort of the wind upon her sails.

To Right the *Helm*, implies to replace it in the middle of the ship, after having put it out of that position.

RIGHTS, Bill of, a declaration delivered by the lords and commons to the Prince and Princess of Orange, Feb. 13, 1688, and afterwards enacted in parliament, when they came to the throne. This may be considered as one grand foundation of English liberty.

RIGIDITY, a brittle hardness; or that kind of hardness which is supposed to arise from the mutual indentation of the component particles of a body.

RILL, in Agriculture, a small runlet of water, mostly rising on the sides of gentle declivities; they are sometimes natural, and sometimes artificial.

RIM, or Brim, a name given to the circular edge of a top. The circumference or circular part of a wheel.

RIND, a skin of any fruit that may be cut off. The outer coat of the chesnut set with prickles, particularly has this name.

RING, for the finger, an ornament of great antiquity and general use, frequently used as badges of office, and denoting the quality of the wearer.

Ring, in Navigation and Astronomy, a brass instrument made in the form of a ring, and serving to take the altitude of the sun.

Ring Bolt, an iron bolt with an eye at one end, wherein is fitted a circular ring. They are used for various purposes, but more particularly for managing and securing the cannon; and are, for this purpose, fixed in the edges of the gun-ports. They are driven through the plank and the corresponding beam or timber, and retained in this position by a small pin thrust through a hole in the small end.

Ring *Ropes*, short pieces of rope, tied occasionally to the ring-bolts of the deck, to stopper or fasten the cable more securely when the ship rides with a heavy strain.

Ring *Tail*, a quadrilateral sail extending on a small mast, which is occasionally erected for that purpose on a ship's taffarel, the lower part being stretched out by a boom, which projects over the stern horizontally.

Ring *Tail*, is also the name of a kind of studding sail hoisted beyond the afteredge of those sails which are extended by a gaff and a boom over the stern. The two lower corners of this sail are stretched out to a boom called a

Ring *Tail Boom*, which rigs in and out upon the main or driver boom, in the same manner that a studding sail boom does on the top-sail yards.

Ring *Worm*, in Medicine, a popular appellation given to various superficial affections of the skin, which assume somewhat of a circular form. The kinds are very different, and require very different treatment.

Ring of Saturn, in Astronomy, is a broad, opaque, circular body, encompassing the equatorial regions of that planet, at a considerable distance from him; which presents, under favourable circumstances, one of the finest telescopic objects in the heavens. An apparent irregularity was first observed in the form of Saturn by Galileo, but his telescope was not sufficiently powerful for him to discover the cause of it; this, however, was soon after effected by Huygens, who, in consequence, published his "New Theory of Saturn," in 1659. This ring, which is very thin, not exceeding 4500 miles, is inclined to the plane of the ecliptic in an angle of $31° 19' 12''$; and revolves from west to east in $10^{h} 29^{m} 16''\cdot 8$, being nearly the time of the diurnal revolution of Saturn, and which is also found, from the laws of Kepler, to be the time in which a satellite would revolve about that planet at the mean distance of the ring; a very remarkable confirmation of the universality of the laws of the planetary motions. This rotation is performed about an axis perpendicular to the plane of the ring, and passing through the centre of the planet. The ring being, as we observed above, very thin, it sometimes nearly disappears, that is, when its plane coincides with or passes through the centre of the earth or sun, at which time it subtends an angle of not more than half a second, and can therefore only be discovered by the most powerful telescopes, through which it has then the appearance of a luminous line beyond the body of the planet. And as this plane is presented to the sun twice during each sidereal revolution of the planet, the disappearance of the ring will happen about every 15 years, and at nearly the same intervals it will appear to the greatest advantage. When viewed in the most favourable position, with a magnifying power of 700, the ring is observed to be divided into two unequal portions by a black concentric line, which is now ascertained to be a real separation, and that what we call the ring of Saturn consists at least of two rings; and some astronomers have even supposed it to be still farther subdivided, and to consist of several circular parts, but this at present is little more than conjecture. The dimensions of this double ring, as given by Dr. Herschel, are as follow:—

| | Eng. Miles. |
|---|---|
| Diameter of the planet, | 76068 |
| Inside diameter, smaller ring, | 146345 |
| Outside, | 184393 |
| Inside diameter, larger ring, | 190248 |
| Outside, | 204883 |
| Breadth of the inner ring, | 20000 |
| ——— of the outer ring, | 7200 |
| Space between the rings, | 2839 |
| ——— between the planet and ring, | 70277 |
| Mean thickness of ring, | 4500 |

The intersection of the plane of the ring with the ecliptic is in $5^s$ 20°, and $11^s$ 20°, in which points therefore it disappears, and between these, *viz.* at $2^s$ 20°, and $8^s$ 20°, it appears most brilliant. As the plane of the ring coincides, or nearly coincides, with the equator of the planet, it is obvious that the ring never becomes visible in his polar regions, and even in those parts nearer the equator it must be very frequently eclipsed by the planet, which last, on the contrary, is as frequently eclipsed by the ring; whence it does not seem that it can be designed to supply these remote regions with light, as some have supposed, as it rather serves to render them more dreary and comfortless; well might the poet say,

> "One moment's cold like theirs would pierce our bone,
> Freeze our heart's blood, and turn us all to stone."

RIOT, rout, and unlawful assembly. When three persons, or more, assemble themselves together, with an intent mutually to assist each other against any who shall oppose them in the execution of some enterprise of a private nature, with force or violence, against the peace, or to the manifest terror of the people, whether the act intended were of itself lawful or unlawful; if they only meet with such purpose or intent, though they shall after depart of their own accord without doing any thing, this is an unlawful assembly. By 34 Edward III. c. 1, it is enacted that if a justice find persons riotously assembled, he alone has not only power to arrest the offenders, and bind them to their good behaviour, or imprison them if they do not offer good bail; but he may also authorize others to arrest them by a bare verbal command, without other warrant: and by force thereof, the person so commanded may pursue and arrest the offender in his absence, as well as presence. It is also said, that after any riot is over, any one justice may send his warrant to arrest any person who was concerned in it, and that he may send him to gaol till he shall find sureties for his good behaviour. The punishment of unlawful assemblies, if to the number of twelve, may be capital, according to the circumstances which attend them; but from the number of three to eleven, it is by fine and imprisonment only. The same is the case in riots and routs by the common law, to which the pillory, in very enormous cases, has been sometimes superadded.

By the act 1 George II. cap. 5. sect. 2, every justice, sheriff, mayor, &c. shall, upon notice of a riot, or unlawful tumultuous assembly of twelve persons, proceed to the place, and make proclamation for them to depart, upon pains of that act commonly called the riot act. If any person shall wilfully oppose or hurt any person going to make proclamation, and prevent the same, he shall be guilty of felony without benefit of clergy. If twelve continue together after proclamation for one hour, it is felony in like manner. And every justice, &c. shall apprehend persons; and if the rioters are killed, the justice, &c. shall not answer for it. A riot, though of fewer persons than twelve, to destroy any church, chapel, meeting, or dwelling-house, out-house, &c. is a capital felony; and the hundred shall answer the damages as in case of robbery.

If two justices go out to quell a riot, they may assemble the *posse comitatus*, and every person capable of travelling is, upon being warned, to join them on pain of imprisonment. 13 Henry IV. c. 7, s. 1, 2, 11, 5. c. 8, s. 2.

It is no uncommon thing to hear, when accidents have occurred at riots, that though the riot act has been read by a magistrate, the people who suffer, or those who make their appearance before a coroner's jury, for the most part swear they never heard one syllable of the act read. In order to announce that the riot act has really been read, the editor once proposed to Viscount Lord Sidmouth, that a flag should be unfurled by the magistrate, or his officer, when the riot act had been read to a seditious or ill-disposed mob. They could all see the flag, who were not blind, though they might not all hear the magistrate's voice, and would be left without excuse, if they did not disperse when the symbol of good order was unfurled in their sight.

RIPPLING, a broken and interrupted noise, produced by a current on or near the sea-coast: the effect of which is also apparent to the eye, by occasioning an ebullition or bubbling up of the water.

RISING, in Astronomy, the first appearance of the sun, moon, or other celestial body, above the horizon.

RISING *Line*, a name given by shipwrights to an incurvated line drawn on the plane of elevation, to determine the height of the ends of all the floor timbers throughout the ship's length and which accordingly ascertains the figure of the bottom with regard to sharpness or flatness.

RISK, the hazard or chance of loss, damage, &c. against which insurances are generally effected; such as against fire, seas, tempest, enemies, &c.

RITUAL, a book directing the order and manner to be observed in celebrating religious ceremonies and performing divine service, in a particular church, diocese, order, or the like.

RIVER, in Geography, a stream or current of fresh water, flowing in a bed or channel from its source or spring into the sea. In Commerce and Political Economy, we may define a river to be a moving road, and the nurse of canals or inland navigation. The doctrine which relates to the flux, reflux, motion, and discharge of rivers, is a branch of hydraulics, and as such forms a part of the present work, though our limits will only admit of a slight sketch of the theory. Water running in open canals or rivers, is accelerated in consequence of its depth, and of the declivity on which it runs, till the resistance increasing with the velocity, becomes equal to the acceleration, when the motion of the stream becomes uniform. But this resistance, it is obvious, can only be determined by experiment; and hence several philosophers have undertaken different courses of experiments for this purpose, amongst whom Buat and Leslie seem to have met with the most complete success.

The same principles which regulate the motion of water in pipes and along canals, extend likewise to the flow of rivers in their beds. Since the propelling power is proportional to the elevation of the main source, the celerity acquired by those descending streams would become enormous, if the force were not gradually absorbed by the operation of some constant impediments. Suppose, such a river as the Rhone to receive its principal waters at the altitude of 900 feet above the level of the sea, and that no system of obstruction had intervened in its course, it would have shot into the Bay of Marseilles with the tremendous velocity of 240 feet in a second, or at the rate of 164 miles every hour. Even an inferior stream, like the Thames, fed at the height of only a hundred feet, would still, if not retarded by the attrition of its bottom and sides, have rushed into the sea with a velocity of 54½ miles in an hour. The resistance of fluids, like the friction of solids, thus enters largely into the economy of nature. As the latter is the great principle of stability and consolidation, so the former serves most essentially to restrain the accumulation of celerity, and to moderate all violent motions. A current presses forwards with increasing rapidity, till the obstruction which it encounters becomes at last equal to the inciting force; and having attained this limit, the water then continues to flow in a uniform stream. The maintaining power is proportional to the quantity of descent in a given space; but the impeding influence depends on the surface of the bed of the river compared with its volume. This obstruction must augment very fast, being as the square of the celerity. If a river should wind considerably, the multiplied deflexions which it suffers, must still farther impede its motion. In every bend which it makes, part of its impulse will be spent against the concave side of the channel; the centrifugal effort will likewise raise the surface of the water in those sinuosities, and therefore augment the abrasion of the banks. Hence, no stream can be long confined to a rectilineal channel. If an accidental swell should once effect a breach, the sweep of the current must necessarily tend to enlarge the concavity by an accelerating progression; the opposite shore, from the accumulation of gravel and other deposits, gradually advancing into the channel. Rivers thus naturally form sinuosities; they seek to meander over the plains; and they would incessantly change their beds, if not restrained by sedulous attention and skilful hydraulic operations. In such a country as Italy, the superintendence of water-courses constitutes an important department of government.

If a flat surface be directly opposed to the action of a stream as it shoots from the side of a vessel, it must evidently sustain a pressure just equal to that which actually projected the fluid, or the load of the incumbent column. In every case, therefore, the impulsion of any current against a perpendicular plane, may be estimated by the weight of a body of the fluid standing upon that surface, and having the altitude due to the velocity.

The pressure of a river against the piers of a bridge, may be hence computed. The shock becomes augmented in a high ratio during floods; for not only is a greater extent of surface then opposed to the current, but the effort on every given space follows also the square of the increased velocity. The mighty rush of a torrent, carrying along with it fragments of rock, stones, or gravel, depends on the same principle. A torrent, with the celerity of eight miles an hour, would therefore be capable of rolling a stone of four foot in diameter. But a stream gliding at the rate of two miles an hour, would only be sufficient to carry along with it a pebble of three inches in diameter. With lower velocities, the current will scarcely move gravel. If the particles of sand were supposed to have a diameter equal to the twenty-fourth part of an inch, it would require a flow of a quarter of a mile in an hour to bear them along. A velocity of the tenth part of a mile in an hour, would only be sufficient to carry sandy particles of the hundred and twenty-third part of an inch in diameter. Hence the theory of the washing of metallic ores, and the deposition of gold dust in the beds of rivers. The ores being broken into very small fragments by means of a stamper, these are laid upon an inclined plane, and exposed to the action of a descending stream of water, which sweeps away all the lighter earthy particles. In like manner the pellicles of gold, adhering commonly to minute portions of quartz, being at length detached by incessant rolling, are left in the little pools, while the sandy particles are still carried farther. Hence also the reason why the bottoms of rapid rivers are covered with large round stones, or at least with rolled pebbles. Where the celerity of the current becomes moderated, gravel and coarse sand begin to appear. But when the flow is sluggish, the bed of the river is always covered with fine sand or mud. Such deposits occur chiefly in the pools, and near the influx into the sea. Hence likewise the gradual formation of banks, a process which is constantly going on over all the stagnant parts of water, and along the limits of opposite currents.

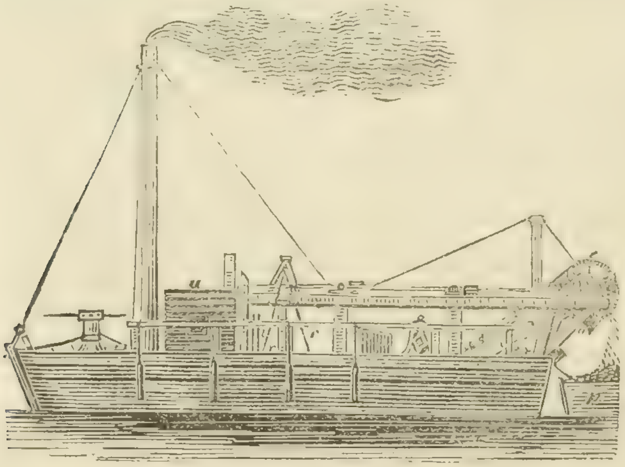
The float-board of a river mill is impelled, not by the whole velocity of the stream, but only by the excess of this above the velocity of the board itself. Hence it would be more advantageous to make the float-boards turn slower, and to multiply their velocity afterwards by means of a train of internal machinery. The current might then strike with nearly its full celerity. In the case of undershot wheels, a grate loss of power is occasioned by the accumulation of the *dead water*, or of the water which, having impinged against a float-board, remains nearly stagnant, and therefore impedes the advance of the next float-board. The shock will evidently be the same, whether a current strikes against a fixed plane, or the plane itself moves with an equal and opposite velocity through a fluid at rest. The formula of impulsion already given, must hence include likewise the case of resistance, which is therefore proportional to the square of the celerity. But this conclusion might be derived from direct considerations. As the plane advances, it receives the stroke of all the particles in its progress. The quantity of momentum thus consumed, is evidently compounded of the number of particles encountered, and the impetus of each; but the number and individual force of those particles being as the velocity, the combined effect must be proportional to the square of the velocity.

*On Dredging Machines*, with a description of one at present employed to deepen the river Clyde.—Dredging was first employed by the Dutch to clean the bars or entrances of their harbours and navigable canals. The first machines were not contrived for lifting mud, gravel, &c. but only for loosening it, so that the sluices constructed for the purpose of cleaning, or scouring, might have more effect. They consisted of large bars, or prongs, placed vertically in a wooden frame, which being fastened to a vessel in the line of the sluices, the whole was impelled forward by the current, and produced a most effectual scour. The first kind of dredging machines used to any extent in this country, consisted of a large plate of iron, about four feet long, and eighteen inches deep, sharpened on the under edge. To each end of it a plank of hard wood was fixed to tenons cut in the iron, whose sharpened edge projected about four inches below the wooden sides, which should be about five long, tapering to ten inches deep at the point, where a bar of iron is fixed to keep the two ends asunder. The whole is formed somewhat like a box, without top or bottom, eighteen inches at one end, and ten inches at the other. To the two ends of the wood a chain is fixed for attaching the principal working rope, or chain. To put the machine in motion, a punt was moored on each bank of the river, directly opposite, and a capstan, or windlass, on each, the one for drawing across the empty dredge, and the other for bringing it back. In the course of its passage, the dredge was commonly filled, and by means of the capstan raised so high, that at low water the stuff could be removed with shovels. Where the shiftings are not frequent, a capstan may be placed on the bank of the river, and the operation carried on as described. Machines on this principle were employed for many years in deepening the Clyde between Glasgow and Dumbarton.

Improved dredging machines, on the principle of an endless chain, were next employed on a large scale, but they have undergone various improvements pointed out by experience. When these machines were first constructed horses were employed as the moving power, which had a circle appropriated to them on board of the vessel that carried the machinery, and were taught to stop by the ringing of a bell. Such machines were long in use in the Humber, at Hull, and in the Clyde at Port-Glasgow and Greenock; those employed at the latter place, had the moving power communicated by men and cranework. The vessels built for them were very flat, and square at both ends, having an aperture up the middle, through which the bucket-frame works, and the stuff was discharged over the end. The application of the steam-engine, however, as a moving power, soon superseded all other modes of performing the operation. Dredging machines, wrought by steam, have been in use on the Thames, at Hull, Bristol, Sunderland, and Aberdeen, and also on that great national undertaking the Caledonian canal. The one which has been lately constructed by Messrs. Girdwood and Co. in Glasgow, and which is at present employed in deepening the river Clyde, so as to admit of large vessels being brought up, does not differ much in its construction from those employed in the Thames and Caledonian canal.

The figure exhibits an elevation of this machine, with the vessel which contains it. The dredge is situated, in this machine, in the centre of the vessel, which has an opening of about two-thirds of its length from the stern, to allow the machine room to touch the bottom to be deepened. The space on each side of this opening in the vessel is fitted up with hammocks,

&c. for the accommodation of the workmen. The remaining part of the vessel towards the head or bow, is occupied by the steam-engine, boiler, stalk, &c. and the dredge discharges the mud and gravel at the stern. When the engine is set on, the motion is communicated to a wheel fixed on the near end of a horizontal shaft, which conveys the motion to another wheel at the farther end, working into a bevelled wheel on the square barrel or axis on which the buckets revolve. The buckets, twenty-two in number, are placed on the links of two endless chains, connected together by the fastenings of the buckets, and revolving round the bucket frame; the length of each link is made to correspond to the side of the square barrel or axis, revolving in the upper end of the bucket-frame, which is supported on the deck of the stern. A similar square barrel or axis, is placed at the lower end of the bucket frame which is immersed in the water, and is elevated or depressed, according to the depth of the bottom, by a chain and pulleys, the end of which terminates in a barrel turned by the engine, when required. When the process of deepening commences, the lower end of the bucket-frame is allowed to descend till it touches the bottom, so that when each bucket arrives at this end of the frame, it scoops out and takes up a load of mud or gravel, and is carried round by the revolving of the chain. This chain, when loaded with the buckets, is supported on the upper side of the bucket frame, by means of a series of rollers, which prevent the great friction which would otherwise be occasioned by the dragging of the heavy buckets on the frame. As each bucket passes over the upper end of the frame, it discharges its contents into punts brought a stern of the vessel. While this process is going on, the vessel is made to move forward by means of a capstan slowly wrought by four men. This capstan winds in a chain made fast to an anchor considerably ahead of the vessel. The punts are first loaded on the one side, and are then turned round to receive a load on the other; when full, they are floated away to the edge of the river, whence the stuff taken out of the bottom is laid alongside of its banks. The quantity brought up at any time must vary considerably, from the nature and depth of the bottom; we have heard it stated, that 30 tons have been raised in seven minutes, in favourable circumstances.



*a*, is the engine-house; *b*, a covered wheel, communicating motion from the engine to the shaft *c*, on the other end of which is the shaft-wheel *d*; *e*, is the square barrel or axis, on which the buckets *o*, *o*, *o*, revolve; *m*, is the bucket-frame; *n*, the double endless chain; *i*, *i*, the friction rollers; *r*, *r*, the regulating chains and pulleys; *l*, the levers for communicating motion to the barrel which moves the chain and pulleys; *p*, the situation of the punts when receiving the mud or gravel raised from the bottom. In the dredging machines used in the Thames, there are two dredges, or endless chains with buckets, one on each side of the vessel, working on the outside, which prevents the necessity of an opening in the centre as above.

**RIXDOLLAR**, a silver coin in different countries on the continent, and of different values, *viz.*:—Rixdollar of Basil, 3s. 6¼d.; Denmark, 4s. 6¾d.; Hamburgh, 4s. 6¾d.; Holland, 4s. 6½d.; Lubeck, 3s. 8½d.; Poland, 4s. 0¼d.; Prussia, 3s. 0d.; Sweden, 4s. 7½d.; Germany, 4s. 8d. standard of 1566; ditto, 4s. 2d. standard of 1753.

**ROACHING** of ALUM, one of the last processes used in the making of alum, and rendering it marketable.

**ROAD**, an open way or passage, forming a commodious communication between one place and another. The ancient Romans were much famed for their attention to roads. Many monuments of their skill and industry still exist, after a laps of sixteen hundred years.

*Common Road.*—The exertions made to obtain a smooth surface is at present one of the most conspicuous features in our system of road-making. This has been effected in a wonderful degree, by a greater attention to the general fabric of the road, and by reducing the metal or stones to smaller dimensions. It must, however, be observed by every one, that our best-formed roads very quickly get out of repair, and that the situation of the traveller is rather tantalizing: for no sooner does he feel the comforts of a smooth path, than an irksome tedium ensues, while he passes along newly laid pieces—the road being almost constantly under repair. Where there is much traffic, it absolutely requires a continued operation, and an unwearied attention, to keep these fine-spun roads in order.

This, indeed, is rendered obvious, even from the quantity of clayey stuff that is raked together in heaps after rains, or is blown about in the state of dust in dry weather. The original cost of a stratum of properly broken road metal, measuring eight inches in depth, in such a situation as Edinburgh, where good rock is to be had in abundance, may be stated to be at the rate of about £2. 10*s.* per rood of 36 square yards. This course of metal laid upon the several approaches to this city requires to be renewed, or would be wholly worn out, in about three years. In the public streets the waste would be proportionally more rapid; and this seems to render the use of small metal unsuitable for a much frequented thoroughfare. Where it has been tried in some instances in England and South Wales, the inhabitants complain "of having all the dust of summer and all the dirt of winter."

*Causeways.*—Were it not for the great expense of causeway, its roughness, and the jarring noise which attends it, this would, no doubt, be generally resorted to both for roads and streets, as is the case in France. The causeway is of two kinds; one termed *ruble*, the other *aisler*. In the former, the stones are irregular both in their figure and dimensions, and they receive hardly any chipping or dressing from the quarrier or paviour. The aisler causeway, on the contrary, consists of stones well assembled, carefully hammer-dressed, and laid in the regular courses across the street, upon a bed of sand. This mode was long considered the perfection of road-making. But the stones being formed with the lower end, or that which is set upon the ground, somewhat smaller than the upper surface, they consequently touch only at or near the top. When, therefore, a pressure comes upon one end of a stone so formed, and set in loose sand, it is easily depressed; when the causeway becomes dislocated, and gets into numerous hollows. The dislocation of the ruble causeway is still more rapid, as the stones rest upon a smaller surface than either the aisler causeway or even the rounded stones in general use in the streets of country towns. These last form a very rough and unpleasant road; but in connexion with the stone-tracks now recommended, they would form most durable and excellent streets.

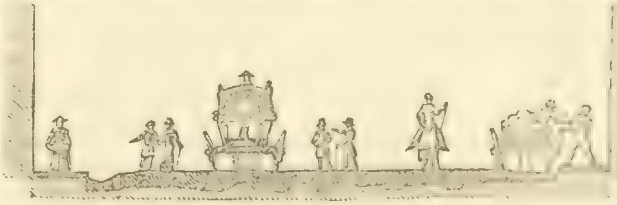
In the neighbourhood of Edinburgh, the expense of aisler causeway is about eight guineas per rood, while ruble work may be estimated at about one half of that sum. Perhaps the finest specimens of British paving are those of the Commercial Road of London, Great Sackville-street in Dublin, and Leith-walk of Edinburgh. This last forms almost the only thoroughfare to the Port; it is nearly two miles in length, and its breadth between the curb-stones, which line off a spacious footpath on each side, may be taken at an average of 58 feet. It is now fourteen or fifteen years since it was converted from a very bad common road into this spacious causeway. Although the surface of this street now exhibits many inequalities, yet with a very little repair it has continued a good road during that comparatively long period, and may continue still as long in the same state.

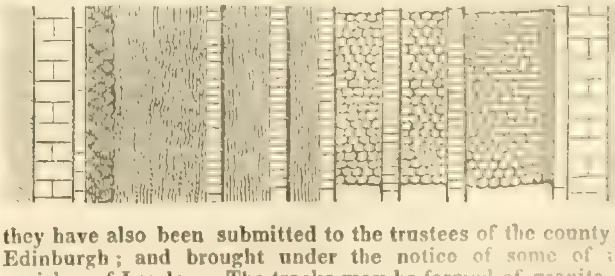
Now, if we compare this with the continual repairs which common roads with a similar traffic demand, we presume that a small metal road would have required to have been renewed every third year, or at least five times, since Leith-walk was paved with aisler causeway. Hence it follows, that in the course of fifteen years, this, which cost eight guineas, must, upon a moderate calculation, have cost about fifteen guineas per rood, including the expenses of raking mud and other contingencies, to which the causeway is but little incident. We here also lay out of view the inconveniency of repairs almost constantly going on, besides the much greater quantity of dust inseparable from the common road. The causeway is, therefore, upon the whole more economical than the small metal road; but this last is more pleasant for the traveller.

*Wheel Tracks of Stone.*—If any one can suggest a system of road-making which shall lessen the ultimate expense, and avoid the inconveniency attending the frequent repair of small metal roads, and at the same time secure all the advantages of a smooth and uniform railway, with the duration of the aisler causeway, we doubt not that its importance will at once be admitted: and if its practicability be also evinced, we trust that it will soon be brought to the fair test of experiment, the result of which may lead to its general adoption. Mr. Stevenson, who is known to our readers as the constructor of the Bell Rock Light House, has proposed improvements in most common roads, by laying stone tracks of a simple construction, upon a firm foundation, if not throughout the whole extent of our principal roads at least upon all their acclivities which exceed a greater rise than at the rate of 1 perpendicular to 26 horizontal feet. (An undulating line of road, which obliges the carrier, in most instances, to modify his load to one-half of what his horse can take along the more level parts.) It is likewise proposed, that the leading streets of all towns and villages situate upon the principal highways, should be laid with these stone-tracks. The traveller would then glide smoothly along, instead of being accompanied with a thundering noise and jolting motion, most unpleasant to himself, and the inhabitants of the respective places through which he passes.

Perhaps the advantages of this system cannot be better exemplified than by noticing an experiment made in presence of some of the directors of the Forth and Clyde Canal Company, upon a set of cast-iron tracks, laid upon an acclivity rising at the rate of about 1 in 15 to Port-Dundas near Glasgow. Here one horse actually drew up a load of three tons on a cart weighing 9 cwt.* In this case the horse proceeded up hill without much apparent difficulty till he reached the top, and was about to enter on the common causeway, when he could proceed no farther although the road had now become level. The carters frequenting this road agree, that their horses had formerly greater difficulty in taking up 24 cwt. on the causeway, than was now experienced with three tons. How great, therefore, must be the beneficial effects of such an immense acquisition of power as even the partial introduction of wheel-tracks is calculated to afford to the traffic of the country. It is to be regretted that cast-iron, which would be so much more durable than stone, is so expensive. It may also be noticed as a drawback to the use of that material for the thoroughfare of a street, that its property of hardness and of getting smooth, even to a state of polish, becomes proportionally disadvantageous. The stone-tracks, on the contrary, preserve a certain degree of roughness, and the numerous joinings suggested by this plan are also favourable to the safety of the horse.

The individual component stones of the wheel-tracks hitherto very partially in use, extend from three to four feet in length, are about ten or twelve inches in breadth, and eight or ten inches in depth. In the neighbourhood of Aberdeen there is a granite railway of this description, which runs several miles along, or in conjunction with the common road. The stones of the tracks should be of a cubical form, measuring only from six to eight inches in the lengthway of the track, and twelve to fourteen inches in depth, eighteen inches in breadth at the base, and twelve inches at the top or wheel-track. The stones are therefore proportionate in all their dimensions; for, unless they contain a mass of matter corresponding to their length, they will be found to want strength and stability. It would hardly be possible to keep slender stone-rails in their places, and hence the chief benefit of a connected railway would be lost. On the other hand, very large materials are difficult to be got, and are also more expensive in carriage, and in workmanship, than stones of a smaller size. The Italian wheel-tracks are composed of stones two feet in breadth, and of various lengths. To lessen the risk of horses falling, these broad stones are kept in a rough state, by occasionally cutting grooves with a pick-axe upon their upper surface. A mode of paving with large blocks of granite, chequered or cut in this manner, has been tried in some of the streets of London. In order, however, to give pavement of this kind the necessary stability, the blocks would require to have their dimensions equally large on all sides, the expense of which would be too great. But cubical stones of the size now recommended may be procured at a moderate price, and throughout a great range of country; while the tracks, if properly laid, will actually be more stable than if blocks of larger dimensions were employed. For we may notice, that a carriage wheel rests or impinges even upon a less surface than one inch of its track at a time, in the course of each revolution round its axis; hence it may be conceived to produce a kind of compensating effect, connected with the use of small stones, which prevents the tremour from being communicated beyond the limited sphere of each particular block, and consequently, extending only a few inches. This system of paving was originally proposed for the Main-street of Linlithgow, forming part of the great western road from Edinburgh to Stirlingshire. Notice has since been taken of it in the Transactions of the Highland Society, vol. vi., and in Dr. Brewster's Encyclopædia, under the article "Roads;" and a correct idea of the plan will at once be acquired by examining the following sketch. By using tracks of this description—giving the stones a proportionably broad bed—and laying them upon a firm foundation, (which is indispensable,) we should have our streets, and the acclivities of our highways, rendered smooth and durable—avoiding, at the same time, the great expense and inconvenience of the common road, and the irksome noise and jolting motion of the causeway. Specimens of these tracks have just been laid in some of the principal streets of Glasgow; they have also been submitted to the trustees of the county of Edinburgh; and brought under the notice of some of the parishes of London. The tracks may be formed of granite, of





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* We trust we shall here be excused for attempting to point out to our readers the benefit of light single horse carts. The team is indeed an emblem of wealth, but it is really impossible to make even two horses work equally. Much as we admire that noble animal, the dray horse of London, we cannot approve of the policy of yoking them in teams. Our feelings have, indeed, been often agitated by seeing the whole load of several tons thrown upon the shaft horse at almost every turn from one street to another. We are, however, far from disapproving of four wheels: and with pleasure we notice an improvement lately made in single-horse waggons with four wheels applied to ordinary purposes. These waggons are 10 cwt., on which a horse weighing about 11 cwt., takes a load of 30 cwt. between Edinburgh and Closeburn, a distance of 66 miles. If wheel-tracks were laid upon the principal acclivities of ordinary roads, horses could work with a load of about two tons.

whinstone, (*i.e.* green-stone or basalt,) or any of the hard varieties of rock capable of being hammer-dressed. Such materials abound in Scotland; in many parts of the north of England, as far south as the approximating sources of the Tees and the Ribble; and in all the districts of Wales. One or more sets of tracks may be laid, according to the nature or extent of the thoroughfare. Let us, for example, suppose that a street, measuring about thirty feet in breadth, be laid out in six compartments, as shewn in the engraving, with a footpath on each side. Three of these compartments are paved with ruble causeway for the horse-paths of the city or town. The remaining three for the highway, are represented as laid with broken stones. The sides of the stones, where they come in contact with each other, are to be dressed so as to form a plain joint across the track, and dressed square, so as to touch throughout the whole surface of the joint. The wheel-track is to be flat, or without any groove, that carriages may move off and on without obstruction. The sides are to be dressed of the sloping form, shewn in the section of the road, but, excepting in the joints across the track and on the top, the stones are only to be hammer-dressed, or chipped after the usual manner. Great care will be necessary, as before noticed, in preparing a firm and compact foundation for the tracks. A stratum of gravel or stone chips, to the depth of three or four inches, laid in lime mortar, according to the nature of the soil, will answer in every case. The laying or building of street stones with mortar, is common in Bath, Paris, and other cities; and unless such a plan be resorted to, the best effects of this system will be lost to the public.

In upholding roads or streets of this description, the intermediate spaces on which the horses go, will seldom require repair. We have seen, in the example of Leith-walk, that aisler causeway has continued in good order for about fifteen years, and, with occasional repairs, may probably last double that period. From this we may conclude, that the tracks will continue for a period of many years. For, although the traffic upon them would be greater than upon the road or street generally, yet it is curious to observe, that however spacious a road may be, carriages are found to go very much in particular lines, one after another; and therefore, the duration of aisler causeway forms a pretty good criterion for judging of the comparative economy of the proposed wheel-tracks. With regard to the expense, we may notice, that in the vicinity of Edinburgh, the lineal yard of two of these tracks will cost about nine shillings, and consequently double of this sum for two sets, to suit carriages travelling in opposite directions. In the ordinary traffic of a city or public road, they may be estimated to last about fifteen years, or as long as three or four strata of common road metal of eight inches in thickness. Not only, therefore, will the comforts of the traveller and those around him be provided for, but the wear and tear of carriage wheels be prevented, and the direct economy of upholding the highways and streets be carried to an immense extent, by the adoption of this system. We are further of opinion, that this system of wheel-tracks is applicable in many situations, where iron railways would either be found too expensive, or where they cannot be introduced with propriety.

During the last few years, public attention has been called to an improved system of road-making, introduced by Mr. M^c Adam. Its chief excellence consists in having a secure foundation or bed, rendered and kept as dry as possible. Over this, the rough materials, reduced to a given size, are laid in regular strata, in such a position that no water may settle on the surface, or penetrate beneath it, as the stones, being angular, soon unite, and become compact by external and successive pressure. This system of road-making answering every expectation in the country, has lately found its way into London, where in many of the streets the pavement has been torn up, and the stones have been broken by the hammer to the dimensions required. There can be no doubt that carriages run with more ease over roads thus constructed and hardened, than over a rough and unbroken pavement. But when the weather is wet, the streets are frequently covered with mud; and when dry, the inhabitants are much annoyed with clouds of dust. The ultimate advantages of this system in the city, remain yet to be discovered.

Under the article **Railway**, we have given a general, but brief account of this modern contrivance for aiding the facilities with which carriages heavily laden may be conducted from place to place. So far as general principle is concerned, all railways are the same; but, like most other inventions, they are susceptible of many improvements in subordinate particulars, among which, the following, by Mr. William James, of Thavies Inn, London, is deserving of special notice in this place, as being nearly allied to the preceding observations on roads. These improvements in the construction of rail-roads, or tram-ways, consist first in making the rails hollow, of whatever form circumstances may render most eligible, the object of which is to reduce the quantity of the metal in the rail, and at the same time to retain the required strength; secondly, in a method of producing a rail with a double road-way, to be firmly fixed as the centre of two lines of rail-way, by which contrivance a saving of one rail in four will be effected; thirdly, in affording the means of conducting water, gas, or other fluid, from place to place, through the hollow tube of the rail; fourthly, in employing the hollow rail, as a trunk to receive ropes, chains, or rods passing from a standing engine, or other actuating machine, for the purpose of protecting these ropes or chains from external injury; and, fifthly, in attaching to such rails or tram-ways, certain rods, wheels, and endless chains, for the purpose of drawing or propelling carriages along the said rail-way, which rods and wheels are to be actuated by means of a stationary steam-engine, or other stationary power. The hollow rails are either to be cast in a mould with a suitable core within, as castings are usually done, or welded, rolled, or otherwise formed to the desired external shape, leaving a recess within; or they may be made partly of metal tubes connected to stone or wooden sides or bottoms, so as to leave the internal part hollow.—This contrivance of rendering the rails hollow may be adapted to any external form of rail, and will be found to save a very great portion of the expense of metal, and yet retain the same degree of strength as if solid.

The construction of a double line of road with three rails only, is to be effected by making the middle rail of sufficient breadth to allow two carriages to pass each other. Fig. 1, is a section of two lines of road constructed of three hollow rails, that in the middle being broad enough to permit the two carriages to pass freely. This contrivance may be extended to a treble line of road, to be formed of four rails instead of six, and so on, by which means a great saving of expense will accrue both in the cost of the rail, and the labour of laying down the lines. The advantages of the broad rail for reducing the number of lines, may be effected without adopting the hollow rail; these central lines may be constructed by joining together pieces of stone, which should be coated with plate iron, or planks of timber.

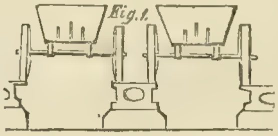


Fig. 1.

The employment of such hollow rails for the passage of water, gas, or other fluid, from one place to another, may be advantageously resorted to, where such objects are desirable, without the expense of additional pipes or tubes; and these hollow rails may also be used with great advantage as trunks for conducting chains, rods, or ropes, passing from standing engines, or other machines employed for the purpose of drawing or propelling carriages along the tram-way, which chains, rods, or ropes would by that means be protected from the weather and other external injuries.

The fifth head of the invention respects the attachment of rods, wheels, gear, and endless chains, to such rails or tram-ways, for the purpose of drawing or propelling carriages thereon, by the agency of stationary engines. One mode of effecting

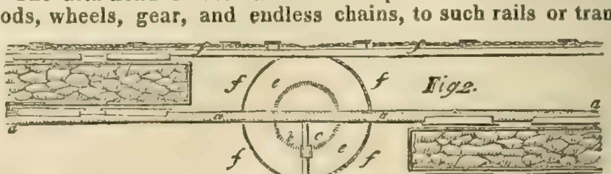


Fig. 2.

this purpose is shewn at fig. 2, which is a plan of a double line or rail-road, and fig. 3, an elevation of the same. Along the central line *a, a*, which is a double rail, a series of rods extend; their extremities being connected together by coupling boxes, clutches, or other means, so as to enable the whole line of rods to turn as one axle, by the actuating power of a steam-engine, or other moving agent, situated at the extremity or in any convenient part of the line. This power may be applied immediately to the rods, or to the toothed wheel *b*, ander the rail-way, which wheel being made to revolve horizontally, and taking into endless screws or pinions upon the rods, cause them to turn. Below the rods the toothed wheel *b* is placed, which revolving horizontally, works into the pinions *c*. fixed upon the rod. Supposing the power of the engine to be communicated to the toothed wheel *b*, by means of a lateral shaft and pinion *d*, the revolution of the wheel *b* would cause the rods *a, a, a*, to turn, and other wheels similar to *b*, being situated at certain distances apart under the rail-way, would also be made to revolve in a horizontal direction, by means of the several pinions upon the central rods. On the same axle, and under the toothed wheel *b*, is the large drum wheel *e*, which revolves with it; round this, and other similar drum wheels, situate on the axles of the toothed wheels, at certain distances apart, the endless chains *f, f, f, f*, are distended, and by the revolution of the drums these endless chains are carried round, supported upon anti-friction rollers, the endless chains being thus actuated, the carriages upon these roads are drawn forward by means of jointed arms *g, g*, extending from the sides of the carriages, which arms have claws at their lower extremities that drop into and take hold of the links of the chains, and thus by the progress of the chains actuated as above described, the carriages are drawn or propelled along the rail-road; and in order to continue their progress past the breaks where the chains embrace the drums, the arms, *g, g*, are set so far apart, that when the foremost arm falls out of action in passing the drum, the hinder arm has still hold of the chain, which continues to drive the carriage forward until the foremost arm has come into action with the next endless chain. Thus a succession of loaded carriages may be advanced along one line of the road, and others returned on the opposite line, by the agency of the endless chains, drums, toothed wheel, and line of rods, actuated by a steam engine, or other moving power, situate at the extremity of the line of rail-road, or any convenient places upon the line. Another mode of impelling carriages upon a similar double line of rails, is proposed by the patentee, varying in a slight degree from the foregoing. Fig. 4, is a plan of such a line, and fig. 5, is a side view or elevation of the same; *a, a*, is a series of rods passing under the central rail connected together by coupling boxes as above described. At suitable distances apart on these rails are bevelled pinions, taking into other bevel pinions at the inner extremities of the cross shafts *b, b*, and at the outer extremities of these cross shafts are rotatory cross arms *c, c*. On the outer side of each tram carriage a sort of ladder *d, d*, is affixed, by arms extending from the axle trees, and thus by the rotation of the central rods *a*, the cross shafts *b*, with their arms *c*, are made to turn; and these cross arms *c*, taking into the ladders and pressing against the rollers of which the ladders are formed, by their rotation drive the carriage forward upon the rail-way.

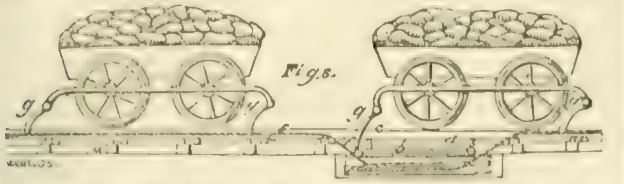


Fig. 3.

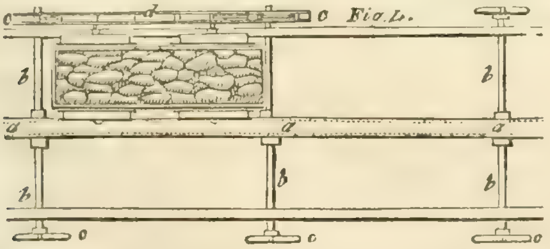


Fig. 4.

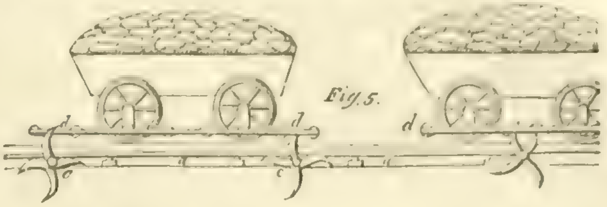


Fig. 5.

**ROAD**, or **Road** *Stead*, a bay or place of anchorage, at some distance from the shore, on the sea-coast, whither ships or vessels occasionally repair, to receive intelligence, orders, or necessary supplies, or to wait for a more favourable wind, &c.

A *Good* **Roadstead**, is that which is protected from the reigning winds and the swell of the sea, has a good anchoring ground, and is a competent distance from the shore.

An *Open* **Road**, is one which is not sufficiently enclosed from the wind and sea.

**ROADER**, or **Roadster**, a vessel riding at anchor in a road, bay, or river. If a vessel under sail strike against any roader and damage her, the former is obliged by law to make good the damages sustained by the latter; roaders are careful to anchor at a competent distance from each other, so as not to intercept each other's departure.

**ROASTING**, in Metallurgy, the separation of volatile bodies from those which are more fixed.

**ROBANDS**, or **Rope** *Bands*, pronounced **Robins**, short flat pieces of rope, having an eye worked in one end: they are used in pairs to tie the upper edges of the square sails to their respective yards; the long leg passing over the yard two or three times round, and the short leg coming under is tied to it upon the yard.

**ROBBERY**, is a felonious taking away of another man's goods from his person or presence against his will, putting him in fear in order to steal the same. The value is immaterial.—If a man force another to part with his property, for the sake of preserving his character from the imputation of having been guilty of an unnatural crime, it will amount to a robbery, even though the party was under no apprehension of personal danger. If any thing is snatched suddenly from the head, hand, or person of any one, without any struggle on the part of the owner, or without any evidence of force or violence being exerted by the thief, it does not amount to robbery. But if any thing be broken or torn in consequence of the sudden seizure, it would be evidence of such force as would constitute a robbery; as where a part of a lady's hair was torn away by snatching a diamond pin from her head, and an ear was torn by pulling off an ear-ring; each of these cases was deemed a robbery.

By 7 George II. c. 21. If any person shall with any offensive weapon, assault, or by menaces, or in any forcible or violent manner, demand any money or goods, with a felonious intent to rob another, he shall be guilty of felony and shall be transported for seven years.

If any person being out of prison shall commit any robbery, and afterwards discover two or more persons who shall commit any robbery, so as two or more shall be convicted, he shall have the king's pardon for all robberies he shall have committed before such discovery.

Highway robbery differs from robbery only in this, that there is a reward of £40 for the apprehending of the offender, and the horse which the robber rides is forfeited.

**ROBERVAL**, **Giles Personne**, an eminent French mathematician, was born in 1602, and died in 1675, at the age of 73.

**ROBINS**, **Benjamin**, a distinguished English mathematician, was born at Bath, in 1707, and early discovered very superior talents, particularly for mathematical and philosophical subjects, which he afterwards pursued with great success.

**ROBUR Carolinum**, the *Royal Oak*. *See* Constellation.

**ROCK**, a stony mass, forming a part of the substance of this globe. Rocks are divided into five classes: namely, 1. Primitive rocks.—2. Rocks of transition—3. Stratified or secondary rocks—4. Alluvial depositions—5. Volcanic rocks.

A *Half Tide* Rock, a rock which appears above water at half ebb.

ROCK Work, any sort of work or design which is formed of fragments of rocks, or large stones, in gardens or pleasure grounds.

Rock *Butter*, in Mineralogy, a saline mineral formed in the fissures of rocks of alum slate. It is a kind of native alum, and feels greasy to the touch, and hence its name.

Rock *Cork*, a flexible and somewhat elastic mineral, found in mineral veins. It is very soft, cracks when handled, but breaks with difficulty; it is so light as to swim, and is almost infusible with the blowpipe, so that it somewhat approximates to asbestos.

Rock *Crystal*, the purest variety of the crystallized quartz.

Rock *Salt*, a natural salt, of the same kind as common table salt. This useful mineral forms large beds and masses in many parts of the world, and even composes entire mountains. In this country, the salt mines of Cheshire are found very productive.

ROCKET, Sky. *See* Fireworks.

Rocket, *Congreve's*. This is a new species of war rockets, deriving their name from the inventor, Sir William Congreve. They differ from the common rocket, as well in their magnitude and construction, as in the powerful nature of their composition; which is such, that without the incumbrance of any ordnance, (the rocket containing the propelling power wholly within itself,) balls, shells, caseshot, and carcasses, may be projected to the distance of from 1000 to 3000 yards, which renders them a most efficacious species of artillery; as they may not only be employed in every case, and for every purpose, of the usual light and heavy ordnance, but they are available also in a variety of instances, in which the nature of the ground, or other impediments, prevent the effectual introduction of that arm. These rockets are of various dimensions, as well in length as in calibre, and are differently armed according as they are intended for the field, or for bombardment and conflagration; carrying, in the first instance, either shells or caseshot, which may be exploded at any part of their flight, spreading death and destruction amongst the columns of the enemy; and in the second, where they are intended for the destruction of buildings, shipping, stores, &c. they are armed with a peculiar species of composition, which never fails of destroying every combustible material with which it comes in contact. The latter are called carcass rockets, and were first used at Boulogne, their powers having been previously demonstrated in some experiments made at Woolwich, by Sir William Congreve, in the presence of Mr. Pitt and several of the cabinet ministers, in the month of September, 1805. Sir Sidney Smith was ordered to command the expedition intended for this purpose; but from the lateness of the season, it being near the end of November before the preparations were completed, nothing was done that year. In 1806, Sir William Congreve renewed his proposition for the attack of Boulogne by rockets, which was ordered to be put in execution after Lord Moira, at that time master-general of the ordnance, and Lord Howick, first lord of the admiralty, had satisfied themselves of the efficacious nature of the weapons, from other experiments made again at Woolwich for that purpose. The attack was accordingly made under the command of Commodore Owen, late in October, 1806; having been put off during the summer months, in consequence of the negociations for peace, at that time pending between the courts of England and France. From this delay, however, instead of being conducted upon the grand scale at first intended, it became a mere desultory attack, in which not more than 200 rockets were fired. The town, however, was set on fire by the first discharge, and continued burning for near two days; it was supposed also that some shipping were destroyed, but the greater part of the rockets certainly went over the basin into the town. After this, their first introduction as a military weapon, the carcass rockets have been used in almost every expedition, and in nearly all under the immediate inspection of their inventor. Their reputation was completely established at Copenhagen, where they did incredible execution: after the siege, they were ordered by Lord Chatham, the master-general of the ordnance, to be reported upon by a committee of field officers of artillery, who had witnessed their effect in that bombordment, and who pronounced them to be "a powerful auxiliary to the present system of artillery." Indeed, the powers of this weapon are now established upon the best of all testimonies, the best of all criterions, the testimony of the enemy; a striking instance of which occurred at the siege of Flushing, where General Monnet, the French commandant, made a formal remonstrance to Lord Chatham respecting the use of them in that bombardment; than which no better fact need be recorded of the effect they must have produced. If such, therefore, be the acknowledged power of the weapon in such an early stage of its progress, and only when a handful, as it were, were used, merely by way of experiment, under the inventor, with not more than twenty or thirty men to assist him, what may not be expected, when regularly organized in the service, and generally combined with the other implements of bombardment?

ROCKY, composed or abounding in stone, slate, &c. as distinguished from sandy, muddy, &c.

ROD, or Pole, a long measure of 16½ linear feet, or square measure of 272¼ square feet.

RODDEN Cribs, in Agriculture, a sort of large wicker-work basket, for containing the hay or other fodder in farm yards.

ROE, the spawn or seed of fish. That of male fishes is usually distinguished by the name of soft roe, or milt, and that of the female by hard roe or spawn.

ROEMER, Olaus, a celebrated Danish mathematician, was born in Jutland in 1644, but spent several years at Paris, during which time he discovered the progressive motion of light by observations on the eclipses of Jupiter's satellites; to him also we owe the theory of epicycloids, and their application to the teeth of wheels in machinery, which De La Hire afterwards wished to appropriate to himself.

ROESTONE, Oolite, in Mineralogy, so called, because it is composed of small round globules, supposed to resemble the roes of fishes, imbedded in a calcareous cement. These globules vary in size from a grain of mustard to that of a pea, and are evidently the result of crystallization.

ROGATION Week, the week immediately preceding Whit Sunday, thus called from three fasts therein.

ROGUE, in Law, an idle and sturdy beggar, who, by ancient statutes, for the first offence was punished by whipping, and boring through the gristle of the right ear with a hot iron. For the second offence, if above the age of eighteen, he was to be put to death.

Rogue's *March*, in Military language, a peculiar beat of the drum, accompanied by fifes, when a soldier is drummed out of a regiment, or prostitutes are expelled a camp or garrison.

Rogue's *Yarn*, a name given to a rope-yarn, which is twisted in a contrary manner to the rest of a rope, and being tarred, if in a white rope, but white if in a tarred rope, is easily discovered; it is placed in the middle of the strand in all cables or cordage made for the king's service to distinguish them from the merchant's cordage.

ROHAULT, James, a French Philosopher, was born in 1620; and very early became a great admirer and advocate of the philosophy of Descartes, in defence of which he wrote his "Physics," which was afterwards translated into Latin by Dr. Clark, with corrections, the best edition of which is 1718.

ROLL, in Law, signifies a schedule or parchment which may be rolled up in the hand into the form of a pipe.

ROLL, or Roller, is also a piece of wood, iron, brass, &c. of a cylindrical form, used in the construction of several machines, and in several works and manufactures.

ROLLE, Michel, a French mathematician, born in 1652, and died in 1685, in his 53d year.

ROLLER, in Gunnery, is a round piece of wood, about nine inches in diameter, and four feet long, used in moving mortars from one place to another when near. Rollers are very numerous, and are applied to various purposes,—in machinery, in agriculture, and in domestic life.

Roller, a cylindrical piece of timber fixed either horizontally or vertically in different parts of a ship, so as to revolve about an axis; it is used to prevent the cables, hawsers, and running rigging, from being chafed, by lessening the friction they would otherwise sustain.

Rollers, are also moveable pieces of wood of the same figure, which are occasionally placed under boats, pieces of timber, &c. in order to move them with greater facility.

ROLLING, that motion of a body, which is caused by its rectilinear motion being resisted, by the friction of some surface or otherwise; whereby its several parts come successively in contact with that plane or surface; such is the motion of a carriage wheel upon the ground, &c. *See* ROTATION.

ROLLING, the motion by which the ship rocks from side to side like a cradle, occasioned by the agitation of the sea. Rolling is accordingly a sort of revolution about an imaginary axis passing through the centre of gravity of a ship, so that the nearer the centre of gravity is to the keel, the more violent will be the rolling motion; because the centre about which the vibrations are made, is placed so low in the bottom, that the resistance made by the keel to the volume of water which it displaces in rolling, bears very little proportion to the force of the vibration above the centre of gravity, the radius of which extends as high as the mast-heads. But if the centre of gravity is placed higher above the keel, the radius of vibration will not only be diminished, but an additional force to oppose the motion of rolling will be communicated to that part of the ship's bottom which is below the centre of gravity. Many fatal disasters have arisen to ships from their violent rolling, as the loss of the masts, loosening the cannon, and straining the decks and sides; it is therefore particularly necessary to guard against it as much as possible, not only in the construction of the bottom, but by causing the centre of gravity of the ship to fall as near the load-water line as possible, which can only be effected by a judicious arrangement of the ballast or cargo.

ROLLING MACHINE, for making the brass mouldings in fenders, and in the brass work of grates. The invention of this machine originated in a cause, which has since operated in producing many others, namely, the reduction of prices at the peace. The usual mode of raising the brass mouldings previous to that period, was by hammering and pressing, which being very laborious as well as tedious, Mr. M'Kinnon turned his attention to the invention of some other mode by which the operation might be rendered more easy and less expensive. The price of the manufactured article had fallen so low, and the wages of the workmen not having suffered a corresponding depression, rendered this almost necessary; and, accordingly, after some trials, the present machine was constructed, which answers the purpose most perfectly. The invention is entirely his own; but a knowledge of its construction, (which is abundantly simple,) having been communicated to some individuals through the medium of workmen who had been with him, it is now generally known to manufacturers in the line, and we therefore consider it unnecessary to withhold it from the public.

*Description of the Machine.*—Fig. 1. A the bottom, and B B the sides or uprights of the frame; *g g*, two moveable rollers, and *d d* guides, of which there are two on each side of the rollers; see fig. 2. When the machine is to be used, it is placed on an iron stand, two feet and a half high, and fastened to the floor. The screws *c c* are then screwed upwards, to separate the rollers so as to admit the flat plate of brass to be moulded. The end of the plate being then inserted between the rollers, the screws *c c* are screwed down, and the rollers turned by handles attached to the square projecting ends *h h*. By this motion, the brass will acquire the same moulding as is formed upon the rollers, of which there are a great variety of patterns. Should the moulding be not completely formed after having gone once through, it is only necessary to screw the rollers tighter together, and pass it through until the accurate form be obtained. The rollers in the drawing are used chiefly for the ornamental brass work of grates. When fenders are to be made, one of the uprights, B, at the left hand, fig. 1, is to be removed to the end of the sole plate, to admit the fenders. The operation of making these, being in every respect the same as described above, it is unnecessary to be more minute.

*Fig.* 2.

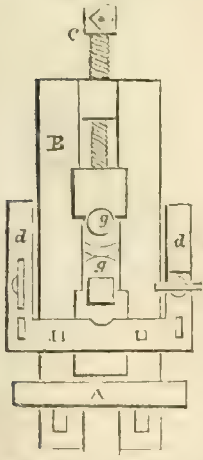
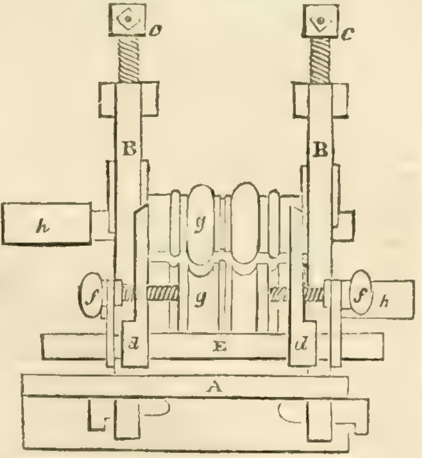


*Fig.* 1.



ROLLING MILL, in Metallurgy, is a mill for reducing masses of iron, copper, or other metals, into even parallel bars, or thin plates. This is effected by passing the metal, whilst red hot, between two cylindrical rollers of steel, put in motion by the mill, and being so mounted in a strong metal frame that they cannot recede from each other, they can press the metal which is passed between them, and reduce it to a thickness equal to the space between their surfaces. Rolling mills have not been in general use until within about ninety years.

ROLLING *Tackle*, a purchase occasionally fixed on the weather quarter of a yard, in order to confine it, and prevent its chafing when a ship rolls heavily.

ROMAIN, in Agriculture, the name of a plant cultivated in the fields, and called by English farmers French vetches.

ROMAN CATHOLICS, in Church History, a name given to those Christians who believe the doctrines and submit to the discipline of the church of Rome. They are also called Papists, from *papa*, father, the pope.

ROMANCE, a fabulous relation of certain intrigues and adventures in love and gallantry, invented to entertain the frivolous and fickle among readers. Sometimes they are instructive, but more generally they are delusive, by representing as true, what has no real existence.

ROOD, a square measure, the fourth of an acre. *See* MEASURE.

ROOF. *See* HOUSE.

ROOK, in Ornithology, a well-known bird of the crow kind. Many curious particulars belong to their natural history.

ROOKERY, in rural economy, a term applied to a nursery of rooks, where they build their nests and collect in large numbers. Rookery is also applied, in cant language, to a house in which females of abandoned character associate.

ROOM, at Sea, a name given to some particular apartment in a ship, as, *the Cook Room.* See the article GALLEY. The *Bread Room*, is in the aftermost part of the hold, being partitioned off and properly lined, to receive the bread, and keep it dry. *Gun Room; Light Room. Steward Room*, the apartment where the steward weighs, measures, and serves out the provisions to the ship's company; it is usually situated on the orlop deck, adjoining to the bread-room. *Sail Rooms*, are places on the orlop deck, enclosed for the reception of the sails; they are distinguished according to their relative situation, as, the fore-sail room, the after sail-room.

*Spirit* ROOM, a space in the after part of a ship's hold, set apart for the reception of wine, brandy, &c.

*Ward* ROOM, a room over the gun-room in ships of war, where the lieutenants and other principal officers sleep and mess.

ROOT, in Arithmetic and Algebra, denotes a quantity, which being multiplied a certain number of times into itself, produces another number, called a power, and of which power the original quantity is called the root. Roots are distinguished into square roots, cube roots, biquadratic roots, &c. or into 2d, 3d, 4th, 5th, &c. roots, which depend upon the number of multiplications necessary to generate the proposed power. If one multiplication only is necessary, or if two equal factors are multiplied together, it is called the square or second root; if three, the cube or third root; if four, the biquadratic or fourth root, &c.: thus 8 is the square root of 64; 4 is the cube root of 64; 2 is the sixth root of 64, &c. &c. For the extraction of the roots of numbers, *see* EXTRACTION.

ROOT, in Mathematics, a quantity considered as the basis or foundation of higher power; or one which, being multiplied into itself any number of times, produces a square, cubic, biquadratic, &c. quantity; called the second, third, fourth, &c. power of the root, or quantity so multiplied into itself.

Root, in vegetable physiology, is an important part of the vegetable body, being the basis of the whole, and what is first produced from the seed when evolved by the process of germination. Its uses are to fix the plant in the ground, and to derive nourishment for its support.

ROPES, are a general name given to all sorts of cordage above one inch in circumference, used in rigging a ship. Ropes are of two descriptions, *viz. Cable-laid,* which are composed of nine strands, the three great strands containing each three small strands; and *Hawse-laid,* which are made with three strands, each composed of a certain number of rope-yarns in proportion to its required thickness.

Rope *Yarn,* the smallest and simplest part of any rope, being one of the threads of which a strand is composed, so that the size of the latter, and of the rope in which it is twisted, are determined by the number of rope-yarns.

ROQUET, in Zöology, the name of a species of American lizard, small in size, of a reddish brown colour, variegated with black and yellow spots. Its eyes are particularly vivid and sparkling.

ROSA, the *Rose,* a fragrant flower, too well known to require any description in this work. The species are exceedingly numerous.

ROSADE, a kind of liquor prepared of pounded almonds and milk, mixed with clarified sugar.

ROSARY, in the Romish church, is a chaplet consisting of five or fifteen decades of beads, to direct the recitation of so many Ave Maria's in honour of the Virgin. It also denotes a particular mass or form of devotion addressed to the Virgin, to which the chaplet of that name is accommodated.

ROSE Engine, a machine used for turning articles in wood like a common lathe, with additional properties, by which the surface of the wood that has been turned can afterwards be engraved with a great variety of patterns of curved lines. These, in general, are denominated from the French rosette, from a distant resemblance which they have to a full-blown rose, and hence, the machine is called a rose engine. Its construction is remarkably curious.

ROSEWOOD, *How to make Imitations of.*—Brush the wood over with a strong decoction of logwood, while hot; repeat this process three or four times; put a quantity of iron filings amongst vinegar; then, with a flat open brush, made with a piece of cane, bruised at the end or split with a knife, apply the solution of iron filings and vinegar to the wood, in such a manner as to produce the fibres of the wood required. After it is dry, the wood must be polished with turpentine and bees-wax.

ROSICRUSIANS, a sect of hermetical philosophers, first noticed in Germany in the fourteenth century. An affected secrecy gave them fame, especially as they pretended to have discovered the philosopher's stone. But when it was proved they had nothing to conceal, they sunk into neglect, and finally into contempt.

ROSIN. *See* Resin.

ROSMARUS, the name of an animal; sometimes called the *Sea Horse,* but more commonly the *Mase.*

ROSMARINUS, Rosemary, a genus of the monogynia order, in the diandria class of plants, and in the natural method ranking under the 42d order, verticillatæ. The corolla is unequal, with its upper lip bipartite; the filaments are long, curved, and simple, each having a small dent. There are two species.

ROSOMACHA, in Zöology, a name given by the Russians to the glutton. Claus says, they are taken by the hunters chiefly for their skins, which are much esteemed by persons of fortune, for robes, the fur being naturally variegated with bright colours resembling flowers.

ROSTRA, in Antiquity, a part of the Roman Forum, in which orations, pleadings, funeral harangues, &c. were delivered. The Rostrum, taken as a sort of chapel out of the Forum, was furnished with an eminence on which the orators stood to speak, and to this elevation the name was more particularly applied. Hence, the term Rostrum has been transferred to pulpits, platforms, and stages, in the present day.

ROSTRUM, in Ornithology, literally denotes the beak of a bird, and is applied to the hard and horny edges of the bill, which answer to the mandible in quadrupeds. Hence the word is figuratively applied to the prow or head of a ship. *Rostrum* is also used to designate an instrument with which paper is ruled for musical compositions. *Rostrum,* in Chemistry, signifies the nose or beak of the common alembic, which conveys the liquor distilled into the receiver. In Surgery, *Rostrum* is a sort of crooked scissars used for the dilation of wounds. It likewise means the piece of flesh situated between the margins of a hare-lip. In Botany, *Rostrum* expresses the beak of a seed, or rather the elongation of the apex of a naked seed.

ROT, in rural economy, a sort of putrid decay taking place gradually, in various substances, either from the effects of moisture, or other causes.

Rot, is also a disease incident to sheep and other animals, in which the liver and lungs are affected, and a tendency to dropsy is produced. It is chiefly connected with moisture, but its causes have not yet been satisfactorily explored.

Rot, *Dry. See* Dry Rot.

Rot, in hops, is a disease in the crops of this valuable article, very similar to mouldiness.

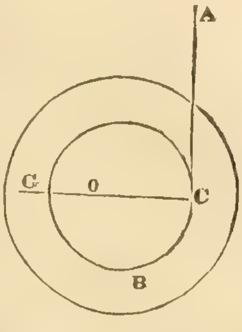
ROTA, in Mechanics. *See* Wheel.

Rota *Aristotelica,* or *Aristotle's Wheel,* denotes a problem in mechanics proposed by Aristotle concerning the motion of a coach wheel; *viz.* that the nave of a wheel describes by its motion, (supposing it to roll along a plane,) a line of the same length as the circumference by its motion on the ground; which was long considered paradoxical, nor was it clearly understood till M. Meyran, a Frenchman, sent a satisfactory solution of it to the Academy of Sciences, the principle of which is, that each point of the circumference of the nave, as it approaches the plane, is drawn forward over a space greater than itself, whereas every point and part of the circumference of the wheel passes over a space exactly equal to itself.

ROTATION, the motion of the different parts of a solid body about an axis called the *axis of rotation,* being thus distinguished from the progressive motion of a body about some distant point or centre; thus the diurnal motion of the earth is a motion of rotation, but its annual motion one of revolution. When a solid body turns round an axis, retaining its shape and dimensions unaltered, every particle is actually describing a circle round this axis, which axis passes through the centre of the circle, and is perpendicular to its plane. Moreover, in any instant of the motion the particle is moving at right angles with the radius vector, or line joining it with its centre of rotation; therefore, in order to ascertain the direction of any particle, we may draw a line from that particle perpendicular to the axis of rotation. This line will be in the plane of the circle of rotation of that particle, and will be its radius vector, and a line drawn from the particle perpendicular to its radius vector, will be a tangent to the circle of rotation, and will represent the direction of the motion of this particle. The whole body being supposed to turn together, it is evident, that when it has made one complete rotation, each point has described the circumference of a circle, and the whole paths of the different particles will be in the ratio of these circumferences, and therefore of their radii; and this is also true of any portion of such circumferences, that is, the velocities of the different particles are proportional to their radii vectores, or to their distances from the axis of rotation. And all these motions are in parallel planes, to which the axis of rotation is perpendicular. Hence it follows, that when we compare the rotation of different bodies in respect of velocity, it is evident that it cannot be done by directly comparing the velocity of any particle in one of the bodies with that of any particle of the other; for as all the particles of each have different velocities, this comparison can establish no ratio. But we may familiarly compare such motions by the number of complete turns which they make in any equal portions of time. Therefore as the length or number of feet described by a body in rectilinear motion is a proper measure of its progressive velocity, so the angle described by any particle of a whirling body is a proper measure of its velocity of rotation; and in this manner may the rotation of two or more bodies be compared, and this velocity is with propriety called the angular velocity. In what is stated above, we have had principally in view a fixed and permanent axis of rotation, the body not being supposed at liberty to revolve about any other; but it is obvious that if any force is impressed upon a body, or system of bodies, in free space, (unless that force be exerted in a direction passing through the centre of gravity of the system) a rotatory motion will ensue about an axis passing through the centre of gravity of the system; and the centre about which this motion is performed, is called the *centre of spontaneous rotation.* A body may begin to revolve on any line as an axis that passes through the centre of gravity, but it will not continue to revolve permanently about that axis unless the opposite centrifugal forces exactly balance each other. Thus a homogeneous sphere may revolve permanently on any diameter, because the opposite parts of the solid, being in every direction equal and similar, the opposite centrifugal forces must be equal; so that no force has a tendency to change the position of the axis. Hence also a homogeneous cylinder may revolve permanently about the line which is its geometric axis; as it may also about any line that bisects that axis at right angles, but it can revolve permanently about no other line, because then the centrifugal forces could not be equal; and the same is true to any solid of rotation.

In every body, however irregular, there are three permanent axes of rotation, at right angles to each other, on any one of which when the body revolves, the opposite centrifugal force exactly balances, and therefore the rotation becomes permanent. These three axes have also this remarkable property, that the momentum of inertia, with respect to any of them, is either a maximum or a minimum; that is, either greater or less than if the body revolved about any other axis. This curious theorem was first proposed by Segner in 1755, and first demonstrated by Albert Euler, in a memoir presented to the academy of sciences at Paris in 1766.

At present we have considered those cases of rotation that are produced by a force impressed upon a body, either as supported on a fixed axis, about which, therefore, that system must necessarily revolve; or as in free space, in which case the system acquires a spontaneous centre of rotation, and finally a permanent axis of rotation: but there are other circumstances which will produce a rotatory motion, that are not included in either of the above, but which it will be proper to mention before we conclude this article, such are those which arise from a body descending down an inclined plane, having a ribbon or cord wound about it, one end of which is fixed at the upper part of the plane, which by preventing the body sliding freely, causes a rotatory motion: the same effect also follows from the friction of the body against the plane; and the same may be imagined when there is no plane but the body left to fall freely, except so far as the cord wound about it shall produce a rotatory motion in its descent. We shall not attempt the investigation of these cases, but merely state the results that have been obtained, and must refer the reader for the former to the several treatises on dynamics refered to in various parts of this volume, and to the articles Dynamics and Mechanics.



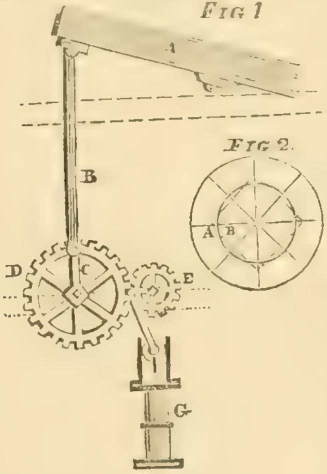
Let a body have a cord wound about it, either at its circumference or any other part, as BC, having one end fixed at a point above, as at A; then if the body be left to descend by the action of gravity, it will acquire a motion of rotation by the unwinding of the cord; and the space actually descended by the body in this case, will be to the space descended in the same time when falling freely, as C G to CO; O and G representing the centres of oscillation and gyration, when the point of suspension is at C: and the weight of the body will be to the tension of the cord, as C O to C G; and the same ratios have place when the body descends down an inclined plane: the forces which generate the motion being both decreased in the same ratio. The force by which spheres, cylinders, &c. are caused to revolve as they move down an inclined plane (instead of sliding), is the adhesion of their surfaces, occasioned by their pressure against the plane; this pressure is part of the weight of the body, for this weight being resolved into its component parts, one in the direction of the plane, the other perpendicular to it; the latter is the force of the pressure; and which while the same body rolls down the plane, will be expressed by the cosine of the plane's elevation. Hence, since the cosine decreases, while the arc or angle of elevation arrives at a certain magnitude, the adhesion may become less than what is necessary to make the circumference of a body revolve fast enough, and in this case it will proceed partly by sliding and partly by rolling; but the angle at which this circumstance takes place, will evidently depend upon the degree of adhesion between the surfaces of the body and plane. This, however, will never happen, if the rotation is produced by the unwinding of a ribbon, and it is on this latter supposition that the following particular cases are deduced. Let W be the weight of the body, $s$ the space descended by a heavy body, falling freely, or sliding freely down a plane, then the spaces described by rotation in the same time, by the following bodies, will be in these proportions.

1. A hollow cylinder, or cylindrical surface $S = \frac{1}{2} s$, tension $= \frac{1}{2}$ W. 2. A solid cylinder $S = \frac{2}{3} s$, tension $= \frac{1}{3}$ W. 3. A spheric surface $S = \frac{3}{5} s$, tension $= \frac{2}{5}$ W. 4. A solid sphere $S = \frac{5}{7} s$, tension $= \frac{2}{7}$ W.

ROTATORY Motion, when produced by a reciprocating motion, requires some contrivance to render it uniform, or nearly so. The usual method of equalizing is, by attaching a fly wheel to some part of the machinery; but Mr. Arthur Woolf has invented an apparatus to be substituted for the fly in steam-engines, which possesses the advantage of equalizing the motion, with the property of being stopped, and set to work at any part of the stroke.

Fig 1

Fig 2.



In fig. 1, A represents part of the engine beam; B, the connecting rod; C, the crank arm; D, a cog wheel, working into another cog wheel E, of half the size; F, a crank arm on the shaft of the small wheel; G, a cylinder closed at bottom, in which a solid or unperforated piston moves, leaving a vacuum beneath. This acts simply instead of a weight on the crank F, by the constant pressure of the atmosphere; and the diameter of the piston must be such as nearly to equal one-third of the power of the engine.

In fig. 2, the outer circle is the line described by the crank; the circumference of the inner circle is equal to twice the diameter of the outer, and the square has the same circumference: this last exhibits the inequality still remaining, which by this method is reduced to about one-fifth; but by the assistance of a small fly on the second motion, the effect will become nearly the same as that of a rotative engine, with the advantages here mentioned. The same motion may be applied to a pump, but in this case the two cranks must be horizontal at the same time.

ROTONDO, or Rotundo, in Architecture, an appellation given to any building that is round both within and without, whether it is a church, a saloon, or the like.

ROTTEN Stone, a decomposed stone used for polishing.

ROUBBIE, a coin of Turkey, value 1*s.* 5½*d.* sterling.

ROUCOU, otherwise called Annotto, is a red dye formed in masses from the pellicles of the seeds of an American tree. That which we commonly have is moderately hard and dry, of a brown colour on the outside, and of a dull red within. Labat informs us, that the Indians prepare a dye of this article far superior to that which we have. It is of a bright shining red colour, almost equal to carmine.

ROUEN, in Agriculture, a term that signifies aftergrass, or the hay made from it.

ROUGH Cast Wash, in rural economy, is a sort of liquid wash laid over the surfaces of outside walls, or buildings, to preserve and ornament them. It consists of four parts of pounded lime, three of sand, two of pounded wood ashes, and one of the scoria of iron, mixed intimately together, and made sufficiently thin to be applied by a brush. When dry, it gives the wall the appearance of new Portland stone, and affords an excellent protection against the severity of the weather.

ROUGH Tree, a name given in merchant ships to any mast, yard, or boom, placed as a rail or fence above the ship's side, from the quarter deck to the forecastle; it is, however, with more propriety applied to any mast, &c. which remaining rough and unfinished, is placed in that situation.

ROUND, in a Military sense, signifies a walk which some officer, attended by a party of soldiers, takes in a fortified place around the ramparts, in the night-time, in order to see that the sentries are watchful, and that every thing is in order.

ROUND House, a name given in East Indiamen, and other large merchant ships, to a cabin or apartment built on the after part of the quarter deck; and having the poop for its roof, this apartment is frequently called the coach, in ships of war.

Round *House*, is also a name given on board ships of war to certain necessaries built near the head, for the use of the mates, midshipmen, and warrant officers.

ROUNDELAY, an antiquated kind of poem, of peculiar metre, at present but little known in this country.

ROUNDING, old ropes wound firmly and closely about that part of a cable which lies in the hawse, or athwart the stem &c. It is used to prevent the cable from being chafed.

Rounding *In*, generally implies the act of pulling upon any slack rope which passes through one or more blocks in a direction nearly horizontal, and is particularly applied to the braces as, "Round in the weather braces." It is apparently derived from the circular motion of the rope about the sheave or pulley through which it passes. *Rounding up*, is used nearly in the same sense, only that it is expressed of a tackle which hangs in a perpendicular direction, without sustaining or hoisting any weighty body, and is opposed to over-hauling. *Round Turn*, the situation of the two cables of a ship, which when moved has swung the wrong way three times successively. *Round Turn*, is also the passing a rope once round a timber head, &c. in order to hold on.

ROUSE, To, is to pull together upon a cable, &c. without the assistance of tackles, capstans, or other mechanical powers.

ROUT, in Law, is an assemblage of more than three persons going forcibly to commit an unlawful act, even though they do not actually execute their intentions. To make advances towards it, is a rout; to execute their designs, is a riet.

ROVER, a pirate or freebooter.

ROW Culture, in Agriculture, is that method in which the crops are sown in drills, and afterwards cultivated according to that system.

ROW, To, to impel a boat or vessel along the surface of the water by oars, which are managed in a direction nearly horizontal.

Row *Dry*, the order to those who row, not to splash water into the boat with their oars.

Row *Locks*, those parts of a gunwale, or upper edge of a boat's side, whereon the oars rest in the exercise of rowing.

Row *Galley*, a long, low, flat-built vessel, sometimes furnished with a deck, and navigated with sails and oars particularly in the Mediterranean.

Rowed *of All*, the order for the rowers to cease and to lay their oars in the boat.

Rowers, the persons by whom the oars are managed.

Row *Forts*, little square holes cut in the sides of small vessels of war, parallel to the surface of the water, for the purpose of rowing them in a calm.

ROWETY Wool, a term applied to the young wool of some sheep, which rises below the old fleece.

ROWLEY Rag, in Mineralogy, a basaltic stone from Rowley, near Dudley, in Staffordshire. It is used for polishing some of the manufactures of Birmingham, and has been strongly recommended for grinding the specula of reflecting telescopes.

ROWNING, John, an ingenious English mathematician, was born about the year 1700, and died in 1771.

ROYAL, the name of a sail spread immediately above the top-gallant sail, to whose yard-arms the lower corners of it are attached: it is sometimes termed top-gallant royal, and is never used but in fine weather.

ROYAL EXCHANGE, the burse or meeting-place of the merchants in London. It was built in 1566, at the charge of Sir Thomas Gresham, and in a solemn manner by herald, with sound of trumpet, in the presence of Queen Elizabeth, proclaimed "The Royal Exchange." Prior to this time the merchants met in Lombard-street. In the great fire in 1666, it was totally consumed, but was soon raised again with still greater magnificence, at an expense of £50,000.

Royal *Society*, in London, is an academy, or body of persons eminent for learning and scientific knowledge, instituted by Charles II. for the promoting of natural knowledge.

RUBIFYING, in Chemistry, the act of turning any thing red by the force of fire. Thus, red arsenic is common white arsenic rubified by a mixture of sulphur and copper.

RUBIGO, a disease in corn when growing, commonly called mildew. For this, various causes have been assigned, but the real source of this agricultural malady still remains partially unexplored.

RUBIN of Antimony, in Chemistry, is a kind of liver of antimony, made with equal parts of crude antimony and nitre detonated together, to which is afterwards added an equal quantity of common salt.

RUBLE, a Russian coin, those of 1764, value 3*s.* 3*d.*; and of 1801, value 2*s.* 9½*d.* sterling.

RUBRIC, in the Canon Law, signifies a title or article in certain ancient law books; thus called because written, as the titles of the chapters of our ancient Bibles are, in red letters. Rubrics also denote the rules and directions given at the beginning and in the course of the liturgy, for the order and manner in which the several parts of the office are to be performed. There are general rubrics, special rubrics, a rubric for the communion, &c. In the Romish missal and breviary are rubrics for matins, for lauds, for translations, beatifications, &c.

RUBUS, the *Raspberry*, a genus of the polygamia order, in the icosandria class of plants; and in the natural order ranking under the 35th order, senticosæ. The calix is quinquefied, the petals five: the berry consisting of monospermous acini, or pulpy grains. There re 32 species.

RUBY, a genus of precious stones of various colours; as 1. Of a deep red colour, inclining a little to purple; the carbuncle of Pliny. 2. The spinell, of the colour of a bright corn poppy flower. 3. The balass, or pale red, inclining to violet. 4. The rubi cell, of a reddish yellow.

RUCTATION, in Medicine, belching, an involuntary discharge of flatus from the stomach. This is a symptom of indigestion. Persons liable to this complaint should carefully avoid fermentive food, in which class all vegetables are included.

RUDDER, in Navigation, a piece of timber turning on hinges in the stern of the ship, and which, opposing sometimes one side to the water and sometimes another, turns or directs the vessel this way or that. *See* Helm.

RUDDOCK, the name of a well-known bird, *Robin red breast.*

RUDIMENTS, the first principles or grounds of any art or science, sometimes called elements.

RUDOLPHINE Tables, a celebrated set of astronomical tables published by Kepler, and thus entitled in honour of the emperor, Rudolph, or Rudolphus.

RUE, in Medicine, a plant well known, the leaves of which have a strong ungrateful odour, and a bitter, hot, penetrating taste. If much handled, they are so acrid as to irritate and inflame the skin. In the Materia Medica rue is of great value, being used in many ways, and applied to various purposes.

RUININE Oil, the oil of the Palma Christi, which is very common in the West Indies, and is used by the common people in lamps. It is delicate, sweet, and transparent; its leaves are one of the grand remedies among the negroes; and when bruised and applied to the head, they are thought to be an infallible cure for the head-ache.

RUINS, a term more particularly applied to magnificent buildings fallen to decay; such as Babylon, Persepolis, &c.

RULE, or Ruler, an instrument of wood or metal with several lines delineated on it, of great use in practical mensuration.

**RULE of Three**, in Arithmetic, called by some authors the *Golden Rule*, is an appellation of the doctrine of proportion to arithmetical purposes, and is divided into two cases, *simple* and *compound*; now frequently termed *Simple* and *Compound Proportion.*

*Simple Rule of Three*, or *Simple Proportion*, is, when from three given quantities, a fourth is required to be found, that shall have the same proportion to the given quantity of the same name, as one of the other quantities has to that of the same name with itself. This rule is, by some authors divided into two cases; *viz. The Rule of Three Direct*, and *The Rule of Three Inverse*; but this distinction is unnecessary, and the two cases are now generally given under one head by all our best modern authors; but as they are still retained by others, it will not be amiss to point out the distinction.

*The Rule of Three Direct*, is when more requires more, or less requires less, as in this example: If 3 men will perform a piece of work, as for instance, dig a trench 48 yards long in a certain time; how many yards will 12 men dig in the same time? where it is obvious, that the more men there are employed, the more work will they perform, and therefore, in this instance, more requires more. Again, if 6 men dig 48 yards in a given time, how much will 3 men dig in the same time? Here less requires less, for the less men there are employed, the less will be the work that is performed by them; and all questions that are in this class are said to be in the Rule of Three Direct.

*The Rule of Three Inverse*, is, when more requires less, or less requires more. As in this, if 6 men dig a certain quantity of trench in 14 hours; how many hours will it require for 12 men to dig the same quantity? Or thus, if 6 men perform a piece of work in 7 hours; how long will three men be in performing the same work? These cases are both in the Inverse Rule, for in the first more requires less, that is, 12 men being more than 6 they will require less time to perform the same work; and in the latter, the number of men being less, they will require a longer time. All questions of this class are said to be in the Rule of Three Inverse. These two cases, however, as we before observed, may be classed under one general rule, as follows:—

*Rule.*—Of the three given terms, set down that which is of the same kind with the answer towards the right hand; and then consider, from the nature of the question, whether the answer will be more or less than this term. Then if the answer is to be greater, place the less of the other two terms on the left, and the remaining term in the middle; but if it is to be less, place the greater of these two terms on the left, and the less in the middle; and in both cases, multiply the second and third terms together, and divide the product by the first term for the answer, which will always be of the same denomination as the third term. *Note* 1. If the first and second terms consist of different denominations, reduce them both to the same; and if the third term be a compound number, it is generally more convenient to reduce it to the lowest denomination contained in it.—*Note* 2. The same rule is applicable whether the given quantities to be integral, fractional, or decimal.

*Central* **Rule.** *See* Central Rule.

*Sliding* **Rule**, a mathematical instrument serving to perform computations in gauging, measuring, &c. without the use of compasses, merely by the sliding of the parts of the instrument one by another, the lines and divisions of which give the answer or amount by inspection. This instrument is variously contrived, and applied to different authors, particularly Gunter, Partridge, Hunt, Everard, and Coggeshall, but the more usual and useful ones are those of the two latter.

*Everard's Sliding* **Rule**, is chiefly used in cask gauging. It is commonly made of box, 12 inches long, 1 inch broad, and $\frac{5}{16}$ of an inch thick. It consists of three parts, *viz.* the stock just mentioned, and two thin slips of the same length, sliding in small grooves in two opposite sides of the stock; consequently when both these pieces are drawn out to their full extent, the instrument is 3 feet long. On the first broad face of the instrument are four logarithmic lines in numbers, for the properties, &c. of which, see Gunter's *Line*. The first marked A, consisting of two radii 1, 2, 3, 4, 5, 6, 7, 8, 9, 1; and then 2, 3, 4, 5, &c. to 10. On this line are four brass centre pins, two in each radius: one in each of them being marked M B, for malt bushel, is set at 215042, the number of cubic inches in a malt bushel; the other two are marked with A, for ale gallon, at 282, the number of cubic inches in an ale gallon. The 2d and 3d lines of numbers are on the sliding pieces, and are exactly the same with the first: but they are distinguished by the letter B. In the first radius is a dot marked S 1, at ·707, the side of a square inscribed in a circle whose diameter is 1 Another dot marked *Sc.* stands at ·886, the side of a square equal to the area of the same circle. A third dot, marked W, is at 231, the cubic inches in a wine gallon. And a fourth marked C, at 314, the circumference of the circle, whose diameter is 1. The fourth line of numbers, marked M D, to signify malt depth, is a broken line of two radii, numbered 2, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 9, 8, 7, &c.; the number 1 being set directly against M B on the first radius.

On the second broad face marked *c d*, are several lines; as first a line marked D, and numbered 1, 2, 3, &c. to 10. On this line are four centre pins, the first marked W G, for wine gage, is at 17·15, the gage point for wine gallons being the diameter of a cylinder whose height is one inch, and content 231 cubic inches, or a wine gallon. The second centre pin marked A G, for ale gage, is at 18·95, the like diameter for an ale gallon. The third mark M S, for malt square, is at 46·3, the square root of 2150·42, or the side of a square whose content is equal to the number of inches in a solid bushel. And the fourth marked M R, for malt round, is at 52·32, the diameter of a cylinder or bushel, the area of whose base is the same 2150·42, the inches in a bushel. 2dly. Two lines of numbers upon the sliding piece, on the other side marked C. On these are two dots, the one marked *c*, at ·0795, the area of a circle whose circumference is 1; and the other marked *d*, at ·785, the area of the circle whose diameter is 1. 3dly. Two lines of segments, each numbered 1, 2, 3, to 100, the first for finding the ullage of a cask, taken as the middle frustum of a spheroid, lying with its axis parallel to the horizon; and the other for finding the ullage of a cask standing. Again, on one of the narrow sides noted *c*, are first a line of inches, numbered 1, 2, 3, &c. to 12, each subdivided into 10 equal parts. 2dly. A line by which, with that of inches, we find a mean diameter for a cask in the figure of the middle frustum of a spheroid; it is marked spheroid, and numbered 1, 2, 3, &c. to 7. 3dly. A line for finding the mean diameter of a cask, in the form of the middle frustum of a parabolic spindle, which gaugers call the second variety of casks; it is therefore marked second variety, and is numbered 1, 2, 3, &c. 4thly. A line by which is found the mean diameter of a cask of the third variety, consisting of the frustums of two parabolic conoids, abutting on a common base, it is therefore marked third variety, and is numbered 1, 2, 3, &c. On the other norrow face marked *f*, are, 1st, a line divided into one hundred equal parts, marked F M. 2ndly. A line of inches, like that before mentioned, marked I M. 3dly. A line for finding the mean diameter of the fourth variety of casks, which is formed of the frustums of two cones, abutting on a common base. It is numbered 1, 2, 3, &c. and marked F C, for frustum of a cone. On the back side of the two sliding pieces is a line of inches, from 12 to 36, for the whole extent of the 3 feet, when the pieces are put endways; and against that, the correspondent gallons and 100th parts that any small tub or the like open vessel will contain at 1 inch deep. For the various uses of this instrument, see the authors mentioned above, and most writers on gauging.

*Coggeshall's Sliding* **Rule**, is chiefly used in measuring the superficies and solidity of timber, masonry, brick-work, &c.

This consists of two parts, each a foot long, which are united together in various ways. Sometimes they are made to slide by one another like glaziers' rulers: sometimes a groove is made in the side of a common two-foot rule, and a thin sliding piece on one side, and Coggeshall's lines added on that side; thus forming the common or carpenter's rule; and sometimes one of the two rulers is made to slide in a groove made in the side of the other. On the sliding side of the rule are four lines of numbers, three of which are double, that is, are lines of two radii, and the fourth is a single broken line of numbers. The first three marked A, B, C, are figured 1, 2, 3, &c. to 9: then 1, 2, 3, &c. to 10; the construction and use of them being the same as those on Everard's sliding rule. The single line called the girt line, and marked D, whose radius is equal to two radii of any of the other lines, is broken for the easier measuring of timber, and figured 4, 5, 6, 7, 8, 9, 10, 20, 30, &c. From 4 to 5 it is divided into 10 parts, and each 10th subdivided into 2, and so on from 5 to 10, &c. On the back side of the rule, are, 1st. a line of inch measure, from 1 to 12, each inch being divided and subdivided. 2ndly. A line of foot measure consisting of one foot divided into 100 equal parts, and figured 10, 20, 30, &c. The back side of the sliding piece is divided into inches, halves, &c. and figured from 12 to 24; so that when the slide is out, there may be a measure of 2 feet. In the carpenter's rule the inch measure is on one side, continually all the way from 1 to 24, when the rule is unfolded, and subdivided into 8th or half quarters; on this side are also some diagonal scales of equal parts. And upon the edge, the whole length of two feet is divided into 200 equal parts or 100ths of a foot.

RULES of Court, in Law, are certain orders made from time to time, in the courts of law, which attorneys are bound to observe in order to prevent confusion; and both the plaintiff and defendant are at their peril also bound to pay obedience to rules made in court relating to the cause depending between them.

RUM, a species of vinous spirit, distilled from sugar-canes.

RUMEN, in comparative Anatomy, the paunch or first stomach of such animals as chew the cud, thence called ruminant animals.

RUMI, in the Materia Medica, a name given to mastic of the finer kind.

RUMINANT, in Natural History, is applied to an animal that chews over again what it has eaten before: this is popularly called, "chewing the cud." *Ruminatio*, in Medicine, and *Rumination*, in Natural Philosophy, are terms of the same family, and of kindred import.

RUN, the aftmost part of a ship's bottom, where it grows extremely narrow as the floor approaches the stern-post. *Run*, is also the distance sailed by a ship. *Run*, is also used among sailors, for the agreement to work a single passage from one place to another; as, from Jamaica to England, &c. *To Run down a Coast*, is to sail along by it. *To Run down a Vessel*, is to pass over her by running against her end-on, so as to sink her. *To Run out the Guns*, is, by means of the tackles, to force their muzzles out of the port-holes. *To Run out a Warp*, is to carry the end of a hawser out from the ship in a boat, and fasten it to some distant place to remove the ship towards that place, or to keep her steady whilst her anchors are lifted, &c. *To let Run a Rope*, is to let it quite loose. *A Run Man*, implies a deserter from a ship of war.

RUNDLET, or Runlet, a small vessel containing an uncertain quantity of any liquor, from three to twenty gallons.

RUNG Heads, a name sometimes given by shipwrights to the upper ends of the floor-timbers, which are otherwise more properly called floor-heads.

RUNIC, a term applied to the language and letters of the ancient Goths, Danes, and other northern nations. Many inscriptions in Runic characters are to be found in this country in old churches, and on monumental stones.

Runic *Shafts*, were a kind of calendars used in the north of Europe, marked out by lines upon short pieces of boards or smooth sticks, some of which bear the marks of great antiquity.

RUNNER, a thick rope used to increase the mechanical power of a tackle. The runner passes through a large block, and has usually a hook attached to one of its ends, and one of the tackle blocks to the other: in applying it, the hook of the runner, as well as the lower block of the tackle, is fixed to the object intended to be removed.

RUNNING Fight, a battle in which the enemy endeavours to escape, while the victor continues to pursue within gun-shot.

Running *Rigging*, all that part of a ship's rigging which passes through blocks, &c. and is used in contradistinction to standing rigging. *The Running part of a Tackle*, is synonymous with the Fall, and is that part on which the power is applied to produce the intended effect.

RUPEE, a coin of different parts of the East Indies, of the sterling value of 2*s*, or a little more or less.

RUPERT'S Drops, a sort of glass-drops with long and slender tails, which burst to pieces on the breaking off of those tails in any part, said to have been invented by Prince Rupert, and therefore called after his name. This surprising phenomenon is supposed to rise from hence, that while the glass is in fusion, or in a melted state, the particles of it are in a state of repulsion; but being dropped into cold water, it so condenses the particles in the external parts of their superficies, that they are easily reduced within the power of each other's attraction, and by that means they form a sort of hard case, which keeps confined the before-mentioned particles in their repulsive state, but when this outer case is broken, by breaking off the tail of the drop, the said confined particles have then a liberty to exert their force, which they do by bursting the body of the drop, and reducing it to a very peculiar form of powder.

RUPELLENSIO SAL, *Rochelle Salt*, a name given to a peculiar kind of salt invented by an apothecary of Rochelle, and much esteemed as a valuable medicine. Its composition was, for a long time, kept a profound secret, but it is now well known to most chemists.

RURAL ECONOMY, is a term which comprehends whatever tends to the improvement of land for the purposes of grazing or agriculture, either by renovating the soil by manure, the arrangement of crops, or the management of the produce.

RUSH. *See* Juncus.

Rush, *Sumach*, a genus of the trigynia order, and in the pentandria class of plants, and in the natural method ranking under the 43d order, dumosæ.

RUSMA, a mineral substance, which, mixed with quicklime, takes off the hair. It was well known to the Egyptians and the Greeks.

RUSPONO, a coin of Tuscany value £1. 8*s*. 6*d*. sterling.

RUST, in Corn. *See* Rubigo.

Rust, in Metal, the partial decomposition of iron and steel: all metallic bodies are liable to rust, even gold is not excepted in some situations. Water is the great agent in producing rust; and when air is assigned as its cause, the aqueous particles it contains is the efficient instrument. Oil, and fat substances, will best preserve metal from corrosion.

RUSTIC, that which is unpolished, partaking more of the simplicities of nature than the refinements of art. The term is applied to men, to their employment, their habitations, and the works they perform.

RUT, in rural economy, a track or narrow opening formed in a road or field by the wheel of a cart, or other carriage, when the rim is narrow.

RUTA Baga, a plant of the turnip kind, that has lately been introduced into this country from Sweden, and is now cultivated with great success. It opportunely comes into use between the turnip and the grass seasons, on which account its value is considerable. Cattle, sheep, and hogs, eat it with great avidity.

Ruta, *Rue*, a genus of the monogynia order, in the decandria class of plants; and in the natural method ranking under the 26th order, multisiliquæ. The calyx is quinquepartite; the petals concave; the receptacle surrounded with ten melliferous pores; the capsule is lobed. In some flowers, a fifth part of the number is excluded. There are seven species.

RUTHERFORD, William, an English philosopher, was born in 1712, and died in 1771. He is principally distinguished by "A System of Natural Philosophy," published in 1748.

RUTHILA, an ore found in Hungary, Italy, and France. It is generally crystallized.

RUTILE, an oxide of *titanium*. It is of a dark blue red colour, inclining to brown, with a degree of metallic splendour. The longitudinal fracture is foliated, the cross fracture conchoidal and unequal. It is opaque, or slightly translucent, and sometimes sufficiently hard to scratch quartz.

RUTULUS, in Roman History, the barrier of the cavea, or place where the wild beasts used in amphitheatrical sports were confined. It was made of iron bars, which turned upon hinges, and flew open when required with great swiftness.

RYE, a species of grain much cultivated in some of the northern districts of England. It approaches nearer to wheat than any other grain now in cultivation. There are several varieties. In many places it is used for bread, but unmixed with wheat, it is dry and poor. By gingerbread bakers much rye is consumed, but the distilleries absorb the greater quantity.

RYELAND SHEEP, a breed of fine-woolled sheep, originally reared to the greatest perfection in a district of Herefordshire, called the Ryelands, from which the name has been derived.

# S.

S, the eighteenth letter of our alphabet: in abbreviations, stands for societas or socius; as R. S. S. for regiæ societatis socius, *i. e.* fellow of the Royal Society. In medicinal prescriptions, S. A. signifies secundum artem, *i. e.* according to the rules of art; and in the notes of the ancients, S. stands for sextus; S P. for spurius; S. C. for senatus consultum; S. P. Q. R. for senatus populusque Romanus; S. S. for stratum super stratum, *i. e.* one layer above another alternately; S.V. B. E. E. Q.V. for, si vales bene est, ego quoque valeo; a form used in Cicero's time, in the beginning of letters. Used as a numeral, S. anciently denoted seven; in the Italian music, S. signifies solo; and in books of navigation, S. stands for south; S. E. for southeast; S. W. for south-west; S. S. E. for south-south-east, &c.

SABAISM, supposed to be the first system of idolatry that ever appeared in the world. It prevailed much in the days of Moses, and is still retained in the East. Sabaism consists of the worship of the stars, or, as the scriptures term it, "the host of heaven."

SABBATARIANS, a sect of Christians, who observe the Jewish or Saturday Sabbath.

SABBATH, the seventh day of the week, held sacred among the Jews, to commemorate the completion of creation. The word is pure Hebrew, and signifies cessation or rest. Philo calls it the world's birth-day. Under the Christian system, it has been transferred to the first day of the week, to commemorate the resurrection of Christ.

SABBATH *Day's Journey*, about two-thirds of an English mile.

SABELLIANS, a Christian sect, who reduced the three persons in the Trinity to three states or relations; or rather reduced the whole Trinity to the one person of the Father, making the *Word* and *Holy Spirit* to be only emanations or virtues.

SABINITES LAPIS, a name given to a stone, in which are preserved the leaves of the common savin.

SABLE, in Zöology, the name of a small animal of the weasel kind, the fur of which is highly valued. In Heraldry, *Sable* is the black colour in the arms of a family.

SABRE, a kind of sword, or scimetar, with a very broad and heavy blade, thick at the back, and a little falcated or crooked towards the point. In the use of this weapon the Turks are said to be so exceedingly dexterous, as to cleave a man quite down with a single stroke. Damascus was formerly famous for its manufacture of sabres.

SACCHARINE ACID. *See* OXALIC *Acid.*

SACCHAROMETER, in the Arts, an instrument for ascertaining the value of worts, and the strength of different kinds of malt liquors. The name signifies a measurer of sweetness.

SACCHARUM, SUGAR, or the *Sugar Cane*, a genus of the digynia order, in the triandria class of plants; and in the natural method ranking under the fourth order, gramina. The calix is two-valved; the corolla is also bivalved. There are eleven species. *See* SUGAR.

SACCOLATS, salts formed from the saclactic acid, and but little known.

SACERDOTAL, something belonging to the priesthood.

SACK OF WOOL, a quantity of wool containing just twenty-two stone, and every stone fourteen pounds. In Scotland, a sack is twenty-four stone, each stone containing sixteen pounds.

SACK of *Cotton Wool*, a quantity from one hundred and a half to four hundred weight.

SACKS of *Earth*, in Fortification, are canvass bags filled with earth. They are used in making entrenchments in haste, to place on parapets, or the head of breaches, &c. or to repair them when beaten down.

SACKBUT, a musical instrument of the wind kind, being a sort of trumpet, though different from the common trumpet both in form and size: it is fit to play a bass, and is contrived to be drawn out or shortened according to the tone required, whether grave or acute.

SACLACTIC ACID, an acid obtained from gum and arabic, and other mucilaginous substances.

SACRAMENT, in general, denotes a sign of something holy or sacred. In the Christian church, baptism and the Lord's supper claim this term; and it has been defined in the ritual of the Establishment to mean, an outward and visible sign of an inward and spiritual grace. Few subjects have been made the occasion of more fierce and unholy contentions than this symbol of peace, good will, and brotherly love.

SACRE, or SAKER, in Ornithology, a species of falcon, exceedingly strong, bold, and active. Ray says, that it will seize upon the largest birds, and even young goats, for food.

SACRIFICE, an offering made to God on an altar. The institution is so ancient as to be deemed nearly coeval with human nature. In some form or other, its adoption seems to be universal. Among Christians, the term is generally restricted to the death of Christ, and the offerings by which that event was typified.

SACRILEGE, is church robbery, or a taking of things out of a holy place, as where a person steals any vessels, ornaments, or goods of the church.

SADAR, the Arabian name of the medicinal lotus, described by Dioscorides and many other ancient writers.

SADDLE, is a seat upon a horse's back, contrived for the convenience of the rider. The ancient Romans are supposed not to have made use of saddles and stirrups, and it has been thought that they did not come into use till the time of Constantine the Great, but this is a great error.

SADDLE, a small cleat or block of wood nailed upon the lower yard arms, to retain the studding sail booms in a firm and steady position; for this purpose the cavity on the lower part of the saddle conforms to the cylindrical surface of the yard to which it is attached, and in like manner the hollow on the upper side answers to the figure of the boom, and serves as a channel whereby it may run out or in along the yards, as occasion requires.

SADDLE, is also a name given to several circular pieces of wood, as the saddle of a bowsprit, saddle of a boom, &c.

SADDLER, one who makes saddles, and furnish necessaries for equestrian equipment. The Saddlers' Company, in London, was incorporated in 1272.

SADDUCEES, an ancient Jewish sect, who denied the resurrection, and the existence of angels and spirits. They were the freethinkers of Israel, highly liberal in principles, but dreadfully cruel in practice.

SAFETY LAMP. To obviate the destructive effects of carburetted hydrogen gas, Sir Humphrey Davy turned his attention to the construction of a lamp which would prevent explosion; and upon the knowledge of the fact, that flame cannot pass through apertures of small diameter, he constructed what the miners have since, in gratitude, called the Davy. *See* LAMP.

SAFFRON, a well-known plant, much cultivated in Cambridgeshire and Essex, and also imported from France, Spain, and Sicily, but that of our own country, when unadulterated, is always preferred. It should be chosen not above a year old, in close, tough, compact cakes, moderately moist, staining the hands when rubbing it, and of the same colour within as on the outside. The cultivation of saffron is attended with much trouble, and requires extraordinary care, and no small degree of patience.

SAFFRON, *Meadow*, a poisonous plant, having a bulbous root, somewhat resembling that of a tulip. Under certain modifications, it has been recommended as a remedy for the gout; but we hear of more mischief than advantage resulting from its cultivation.

SAFFRON *Tree*, an East Indian shrub, which grows about two feet high. The flowers, which resemble those of the jessamine, never open but in the night, and seldom continue more than three or four days. They have no smell, but exhibit the colour of saffron, and their cordial virtues are much the same.

SAFFRON, is also a name given to several chemical preparations, from their resemblance in colour to vegetable saffron.

**SAGAPENUM**, a medicinal gum resin, whose smell resembles that of a pine.

**SAGARA**, in Hindoo Mythology, is a personification of the ocean.

**SAGATHEE**, a slight kind of woollen stuff, serge, or ratteen, sometimes mixed with a little silk.

**SAGDA**, the name of a particular stone of a green colour, having the property of attracting wood.

**SAGE.** *See* Salvia.

**SAGENE**, a Russian long measure, five hundred of which make a verst, equal to seven English feet.

**SAGGING to Leeward**, the movement by which a ship makes a considerable lee-way, or is driven far to leeward of the course whereon she apparently sails. It is generally expressed of heavy sailing vessels, as opposed to keeping well to windward, or, in the sea phrase, holding a good wind.

**SAGITTA**, the *Arrow*, one of the northern constellations. *See* Constellation.

**Sagitta**, in Trigonometry, is the same as the versed sine of any arch, and is so called, because it resembles a dart or arrow standing on the chord of an arc.

**Sagitta**, in Geometry, is used by some old authors, to denote the absciss of any curve.

**SAGITTARIUS**, the *Archer*, ♐, is the last of the autumnal, and the third of the southern signs, agreeably to the fixed zodiac; and the sun accordingly enters it on the 22d of November. But reckoning by the visible and moveable zodiac, Sagittarius is actually in possession of the first winter sign, for the sun enters it about the 7th of December, as is obvious by reference to the Celestial Globe.

*Boundaries and Contents.*—Sagittarius is bounded on the north by Scutum Sobieski and Antinöus; east by Capricornus and Microscopium; south by Corona Australis, Indus, and Telescopium; and west by Scorpio. It contains sixty-nine stars, *viz.* five of the third magnitude, nine of the fourth, &c. One of the largest stars in this sign, and δ, is situated by the middle of the bow, and rises on the south-east by S. ¼ E. point of the horizon, at London. Its declination is 29° 54′ 33″ south; its right ascension 272° 21′ 57″; and it rises and culminates as in the following table, for the first day of every month in the year: Meridian altitude 8° 34′ 27″.

| Month. | Rises. | Culm. | Month. | Rises. | Culm. |
|---|---|---|---|---|---|
| | ho. mi. | ho. mi. | | ho. mi. | ho. mi. |
| Jan. | 8 30 M. | 11 25 M. | July | 3 32 A. | 11 25 A. |
| Feb. | 6 18 M. | 9 10 M. | Aug. | 6 40 A. | 9 30 A. |
| Mar. | 4 25 M. | 7 20 M. | Sept. | 4 35 A. | 7 30 A. |
| April | 2 35 M. | 5 25 M. | Oct. | 2 50 A. | 5 40 A. |
| May | 12 45 M. | 3 35 M. | Nov. | 12 54 A. | 3 50 A. |
| June | 10 30 A. | 1 20 M. | Dec. | 10 47 M. | 1 45 A. |

**SAGO**, a simple brought from the East Indies, of considerable use in diet, as a restorative. It is produced from the pith of a kind of palm which grows in the East Indies, called the cycas circinalis.

**SAGOUIN**, in Zöology, the name of a beautiful species of monkey.

**SAGUM**, the name of a military garment worn by the Greeks, Romans, and Gauls, in the manner of a cloak or cassock.

**SAGWIRE**, a liquor in the East Indies, drawn from a tree of the palm kind, of the same nature as toddy or palm wine. It is refreshing, wholesome, but inebriating.

**SAIC**, a sort of Grecian ketch, which has no top-gallant sail nor mizzen sail.

**Saic**, an assemblage of several breadths of canvass, or other texture, sewed together, and extended on or between the masts, to receive the wind, and impel the vessel through the water. The edges of the cloths or pieces of which a sail is composed are generally sewed together with a double seam, and the whole is skirted round at the edges with a cord called the bolt-rope.

**SAICK**, a Turkish vessel rigged in a peculiar manner, and well adapted for the conveyance of merchandise.

**SAIGA**, in Zöology, a species of antelope, the characters of which are, that the horns are pale, and almost transparent, distant at their bases, and bent in form of a lyre. It inhabits Poland, Moldavia, the Carpathian mountains, Caucasus, and may be found on the borders of the Caspian and Euxine sea. Its residence is generally in the open desert, in which salt springs abound, and its food is saline, acrid, and aromatic vegetables.

**SAILS**, are all contained either between three or four sides; or, as they are otherwise termed, they are either triangular or quadrilateral. The former of these are sometimes spread by a yard, as lateen sails, or by a stay, as stay sails, or by a mast, as shoulder of mutton sails; in all which cases the foremost leech or edge is attached to the yard, mast, or stay, throughout its whole length. The latter, or those which are four-sided, are either extended by yards, as the principal sails of a ship, or by yards and booms, as the studding sails, drivers, ringtails, and all those sails which are set occasionally; or by gaffs and booms, as the main-sails of sloops and brigantines. The principal sails of a ship are the courses or lower sails; the top sails, which are next in order above the courses, and the top gallant sails, which are extended above the top sails. The courses are, the main-sail, fore-sail, and mizzen; the sprit-sail, main stay-sail, fore stay-sail, and mizzen stay-sail: but more particularly the three first. The main stay-sail is rarely used, except in small vessels. In all the quadrilateral sails, the upper edge is called the head, the sides or skirts are called leeches, and the bottom or lower edge is termed the foot; if the head is parallel to the foot, the two lower corners are denominated clues, and the upper corners earings. In all triangular sails, and in those four-sided sails wherein the head is not parallel to the foot, the foremost corner at the foot is called the tack, and the after lower corner the clue: the foremost head is called the fore leech, and the hindmost the after-leech. The heads of most four-sided sails, and fore-leeches of lateen sails, are attached to their respective yard or gaff by a number of small cords called robands, or by a lacing, and the upper extremities are made fast by earings. The stay-sails, are extended upon stays between the masts, whereon they are drawn up or down occasionally, as the curtain slides on its rod, and their lower parts are stretched out by a tack and sheet. The main-sail and fore-sail have a rope and a large single block made fast to each clue; the ropes called tacks lead forward to the chess trees and bumkins, and the block receives a thick rope from aft, which is termed the sheet. The clues of the top-sails are drawn out to the extremities of the lower-yards, by two large ropes called top-sail sheets, and the clues of the top-gallant sails are in like manner extended upon the top-sail yard-arms by ropes called top-gallant sheets. The royals are set above the top-gallant sails, and the studding sails beyond the leeches or skirts of the main-sail and fore-sail, and of the top-sails and top-gallant-sails, their upper and lower edges being extended by small yards, and by poles run out beyond the extremities of the yards for this purpose. These sails are, however, only used in moderate weather. All sails derive their name from the mast, yard, or stay, upon which they are extended. Thus the principal sail extended upon the main-mast is called the main-sail; the next above, which stands upon the main-top-mast, is termed the main-top sail; that which is spread across the main-top gallant mast, is named the main-top-gallant sail; the sail above it is called the main-royal. In the same manner there are the fore-sail, fore-top sail, fore-top-gallant sails, and fore-royal; the mizzen, mizzen-top sail, mizzen top-gallant sail, and mizzen royal. Thus also there are the main-stay sail, main top-mast-stay sail, main top-gallant-stay sail, and a middle stay sail, which stands between the two last); all these stay-sails are between the main and fore mast; the stay sails between the main and mizzen masts are the mizzen stay sail, the mizzen top-mast stay sail, the mizzen top-gallant stay sail, and sometimes a mizzen royal-stay sail. The sails between the fore-mast and the bowsprit are the fore stay-sail, the fore top-mast-stay sail, the jib, and sometimes a flying jib; and even a middle jib: there are besides two and sometimes three square sails extended by yards under the bowsprit and jib-booms, one called the sprit-sail, the second the spirit-sail top-sail, and the third the sprit-sail top-gallant sail; the studding sails being extended upon the different yards of the main-mast and fore-mast, are also named, according to their stations, the lower top-mast, or top-gallant studding-sails. The ropes by which the lower yards of a ship are hoisted up to their proper height on the masts are called the jears; in all other cases the ropes employed for this purpose are called halliards; hence the sails are expanded by halliards, tacks, sheets, and bow lines; and are drawn up together, or trussed up, by bunt-lines, clue-lines, leech-lines, reef-tackles, slab-lines, and spilling-lines, the higher studding-sails, and the stay-sails are drawn down so as to be taken in by down-hauls, and the courses, top-sails, and top-gallant sails, are wheeled about the mast so as to suit the various directions of the wind by braces.

*After* SAILS, are those that belong to the main mast and mizzen. They keep the ship to windward, on which account ships sailing on a quarter wind require a head-sail and an after sail, one to countermand the other.

*Netting* SAIL, is only a sail laid over the nettings.

SAIL, is also applied to a vessel seen at a distance under sail, as "We saw three sail in the north-east."

To *Set* SAIL, is to expand the sails in order to begin the action of sailing. *To loose Sails*, is to unfurl them, and to let them hang loose to dry. *To make Sail*, is to extend an additional quantity of sail, so as to increase the ship's velocity. *To shorten Sail*, is to reduce or take in part of the sails. *To strike Sail*, is to lower it suddenly, which is particularly used in saluting or doing homage to a superior force, or to one whom the law of nations acknowledges as superior in certain regions. Thus all foreign vessels strike to an English man-of-war in the British seas. See the article SALUTE.

**SAILING**, in Navigation, denotes the act of conducting a vessel from one port to another, by means of the action of the wind upon her sails, being otherwise expressed by the most significant term, Navigation.

SAILING, is distinguished into different cases, according to the principles upon which the computations are founded, as *Plane Sailing, Middle Latitude Sailing, Mercator Sailing, Globular Sailing*, &c.

*Plane* SAILING, is that which is performed on a supposition of the earth being an extended plane surface, and by means of plane charts, in which case the meridians are considered as parallel lines, the parallels of latitude at right angles to the meridians, and the lengths of the degrees on the meridians, equator, and parallels of latitude, as every where equal. Here the principal terms are the latitude, distance, and departure; difference of latitude and rhumb, longitude having no place in plane sailing. It is obvious, however, that calculations conducted on these principles must be too erroneous to be depended upon in any case, and therefore it would be but wasting the reader's time to enter farther into an explanation of this case, which is now nearly if not wholly disused by navigators.

*Traverse* SAILING, may be defined compound plane sailing, being the method of working, or calculating traverse or compound courses so as to reduce them into one. This is used when a ship, having to sail from one port to another, is by reason of contrary winds, or other obstacles, obliged to tack and sail upon different courses, which are then to be brought into one; and hence the difference of latitude, departure, and other circumstances, determined as in plane sailing.

*Globular* SAILING, is the method of estimating a ship's motion and run, upon principles drawn from the globular figure of the earth. In this its most extended sense, globular sailing comprehends *Parallel*, *Mercator*, *Middle Latitude*, and *Great Circle Sailing*; for a definition of each see the following articles.

*Parallel* SAILING, is the sailing on a parallel of latitude, or parallel to the equator, of which there are three cases.

1. Given the distance and difference of longitude; to find the latitude, which is performed by the following rule:—As the difference of long.: the distance : : the radius: the cosine of the latitude.

2. Given the latitude and difference of longitude; to find the distance. Rule. As radius: the cosine of the latitude : : the difference of longitude : the distance.

3. The latitude and distance being given to find the difference of longitude. Rule: As cosine of latitude : radius : : the distance : the difference of longitude.

*Middle Latitude* SAILING, is a method of resolving the cases of globular sailing, by means of the middle latitude between that departed from and that come to. This method is not accurate, being founded on the principles of plane and globular sailing conjointly; *viz.* on a supposition that the departure is reckoned as a meridional distance in that latitude, which is the middle parallel between the latitude sailed from and the latitude come to: which would be correct, if the cosine of a middle latitude was an arithmetical mean between the cosine of two extreme latitudes; and the departure between two places on an oblique rhumb, equal to the meridional distance in the middle latitude; but neither of these cases obtain. Yet when the parallels are near the equator, or near to each other, in any latitude, the error is not considerable. This method seems to have been invented on account of the easy manner in which the several cases may be resolved by the traverse table; and when a table of meridional parts is not at hand, the computations may be made as follows; *viz.* Take half the sum of the two given latitudes for the middle latitude, then say,

1. As cosine of mid. lat. : the radius : : the departure : diff. of longitude.

2. As cosine of mid. lat. : tan. of course : : diff. of lat. : diff. of longitude.

*Right* SAILING, is when a voyage is performed on some one of the four cardinal points. If a ship sail under the meridian on the north or south points, she varies not in longitude. If she sail under the equinoctial on the east or west points, she changes only the longitude. If from any place she sails directly east or west, she only alters the longitude.

*Oblique* SAILING, though in many cases the bearing and distances of places are determined by the solution of right-angled triangles, yet at sea there are several in which oblique positions can be observed. The doctrine of plane triangles is also applicable to the method of sailing by windward. It may be observed, in general, that when the wind is directly or partly against the ship's direct course to the place whither she is bound, she reaches her port by a kind of zigzag or z-like course, which is made by sailing with the wind first on one side of the ship and then on the other. The windward or weather-side of a ship is that side on which the wind blows; the other being called the leeward or lee side. When a ship sails the same way the wind blows, and the wind is said to be right aft, or right astern, her course is then sixteen points from the wind. When a ship sails with the wind blowing directly across her, she is said to have the wind on the beam, and her course is eight points from the wind. When a ship endeavours to sail towards that point of the compass from whence the wind blows, she is said to sail on the wind, or to ply to windward. A vessel sailing as near as she can to the point from whence the wind blows, is said to be close hauled: most ships will lie within about six points of the wind, but sloops and some other vessels will lie much nearer. When a ship sails on a wind, the windward tacks are always hauled forwards and the leeward sheets aft. The starboard tacks are aboard when the starboard side is to windward, and the larboard to leeward; the larboard tacks are aboard when the larboard side is to windward, and the starboard to leeward. In order to know how near the wind a ship will lie, observe the course she goes on each tack, when she is close-hauled; then half the number of points between the two courses will shew how near the wind that ship will lie. The most common cases in turning to windward may be constructed by the following precepts. Having drawn the meridian and parallel of latitude (or east and west line) in a circle representing the horizon of the place, mark in the circumference of the place of the wind; draw the rhumb passing through the place bound to, and lay thereon the distance of that place from the centre. On each side of the wind, lay off in the circumference the points of degrees, shewing how near the wind the ship can lie, and draw these rhumbs; the first course will be on one of these rhumbs, according to the tack the ship leads with; draw a line from the place bound to, parallel to the other rhumb, and meeting the first, and this will shew the course and distance on the other tack.

*Mercator's* SAILING, is the art or resolving the several cases of globular sailing by plane trigonometry, with the assistance of a table of meridional parts, or of logarithmic tangents. Meridional parts, miles, or minutes, are the parts by which the meridians in a Mercator's Chart increase, as the parallels of latitude decrease. The cosine of the latitude of any place being equal to the radius or semi-diameter of that parallel; therefore, in the true sea-chart, or nautical planisphere, this radius being the radius of the equinoctial, or whole sine of ninety degrees, the meridional parts at each degree of latitude must increase as the secants of the arch contained between that latitude and the equinoctial decrease. The manner of working with the meridional parts, and logarithmic tangents, will appear from the two following cases.

1. Let the latitudes of two places be given, and the meridional difference of latitude between them be required. By the meridional parts, when they are on the same side of the equator, say the difference; when on different sides, the sum of the meridional parts answering to each latitude will give the meridional difference of latitude required. By logarithmic tangents, when they are on the same side of the equator, say the difference of the logarithmic tangents; when on different sides, the sum of the logarithmic co-tangents, abating the index of the half co-latitudes, divided by 12,63, will give the meridional difference of longitude required.

2. Let the latitude of one place and the meridional difference of latitude between that and another place be given, and the latitude of the other place be required. The sum of the meridional parts of the given latitude, and the given meridional difference of latitude, when they have like names, found in the table of meridional parts, will give the latitude sought. Or, multiply the given meridional differences of latitude by 12,68, and in the former case subtract, but in the latter case add the product to the logarithmic tangent of the given half co-latitude, the degrees corresponding to the tangent of the remainder, or of the sum, being doubled, will give the co-latitude required.

*Circular, or Great Circle* Sailing, is the art of finding what places a ship must go through, and what courses to steer, so that her track shall be in the arc of a great circle, or nearly so, passing through the place sailed from, and that bound to. This method of sailing has been proposed, because the shortest distance between two places on the sphere is an arc of a great circle intercepted between them, and not the spiral or rhumb passing through them, unless that rhumb coincides with a great circle which can only be on a meridian or on the equator. As the solutions of the cases in Mercator's sailing are performed by plane triangles, in this method of sailing they are resolved by the means of spheric triangles. To bring sailing to certain rules, M. Renau computes the force of the water against the ship's rudder, stern, and side, and that of the wind against her sails. In order to this, he, 1. considers all fluid bodies, as the air, water, &c. as composed of little particles, which when they act upon or move against any surface, do all move parallel to one another, or strike against the surface after the same manner. 2. That the motion of any body, with regard to the surface on which it is to strike, must be either perpendicular, parallel, or oblique. The author then proceeds to illustrate his observations with several examples.—Another author on this subject observes, when a ship changes her state of rest into that of motion, as in advancing out of a harbour, or from her station at anchor, she acquires her motion very gradually, as a body which arrives not at a certain velocity till after an infinite repetition of the action of its weight. The first impression of the wind greatly affects the velocity, because the resistance of the water might destroy it, since the velocity being but small at first, the resistance of the water which depends upon it will be very feeble, but as the ship increases her motion the force of the wind on her sails will be diminished; whereas, on the contrary, the resistance of the water on the bow will accumulate in proportion to the velocity with which the vessel advances. Thus the repetition of the degrees of force which the action of the sails adds to the motion of the ship, is perpetually decreasing, while, on the contrary, the new degrees added to the effort of resistance on the bow, are always augmenting. The velocity is then accelerated in proportion as the quantity added is greater than that which is subtracted; but when the two powers become equal, when the impression of the wind upon the sails has lost so much of its force as only to act in proportion to the opposite impulse of resistance on the bow, the ship will then acquire no additional velocity, but continue to sail with a constant uniform motion. The great weight of the ship may indeed prevent her from acquiring her greatest velocity, but when she has attained it, she will advance by her own intrinsic motion, without gaining any new degree of velocity, or lessening what she has acquired. She moves then by her own proper force, *in vacuo*, without being afterwards subject either to the effort of the wind on the sails, or to the resistance of the water on the bow. If at any time the impulsion of the water on the bow should destroy any part of the velocity, the effort of the wind on the sails will revive it, so that the motion will continue the same. It must, however, be observed, that this state will only subsist when these two powers act upon each other in direct opposition, otherwise they will mutually destroy one another. The whole theory of working ships depends on this counteraction, and the perfect equality which should subsist between the effort of the wind and the impulsion of the water.

*Order of* Sailing, the general disposition of a fleet of ships when proceeding on a voyage or an expedition. It is generally found most convenient for ships of war to be formed in three parallel lines or columns.

**SAIL-LOFT**, a large apartment in dock-yards, where the sails are cut out and made.

**SAILMAKER**, a subaltern officer on board ships of war, who, with his mates, has the care of repairing or altering the sails, according to the captain's directions.

**SAILOR**, a person trained in the exercise of fixing the machinery of a ship, and managing her either at sea, or in a road or harbour.

**SAINTFOIN**, in Agriculture, a species of plant, of the artificial grass kind, frequently raised as food for cattle, both green and dried: it is sometimes called holy-hay, or wholesome hay, from its peculiar nutritive qualities. It rises in the stem from one to two feet high, and has tufts of red flowers from three to five inches in length. It was originally brought into this kingdom from France, or the Low Countries.

**SAKER**, a name formerly used for a small species of cannon, of which there were three sorts.

**SAL AMMONIAC**, in Chemistry, a salt composed of muriatic acid and ammonia, or the volatile alkali. This substance, highly refined, is called spirits of hartshorn.

Sal Ammoniac, in the Materia Medica, is an inodorous salt, of a bitterish, acid, and cool taste; persistent in the air, and not easily reduced to powder.

**SALACASE**, the name given to a bird in the Philippine islands, by whose flight the inhabitants pretend to foretell future events.

**SALAD** Herbs, in Gardening, esculent plants, from which salads are collected. These are of various kinds, and are now procured at all seasons of the year.

**SALAGRAMA**, a stone found in the river Nepaul, and considered by many sects of Hindoos as sacred, and containing something mystical.

**SALAMANDER**, a name given to several species of lizards. Of this creature many strangely fabulous accounts have been published.

**SALARY**, a stipend allowed to any person, in consideration of his industry and services, in another man's business.

**SALAYASIR**, a small species of duck, not larger than a pigeon, inhabiting the marshes of the Philippine islands. It is most beautifully coloured.

**SALE** of Goods. If a man agrees for the purchase of goods, he shall pay for them before he carries them away, unless some term of credit is expressly agreed upon by the parties. If a man, upon the sale of goods, warrants them to be good, the law annexes to this contract a tacit warranty, that if they be not so, he shall make compensation to the purchaser: such warranty, however, must be on the sale. But if the vender knew the goods to be unsound, and has used any art to disguise them, or if in any respect they differ from what he represents them to be to the purchaser, he will be answerable for their goodness, though no general warranty will extend to those defects that are obvious to the senses. If two persons come to a warehouse, and one buys, and the other, to procure him credit, promises the seller, "If he do not pay you, I will;" this is a collateral undertaking, and void without writing, by the statutes of frauds; but if he say, "Let him have the goods, I will be your paymaster," this is an absolute undertaking as for himself, and he shall be intended to be the real buyer, and the other to act only as his servant. The question in these cases is always, which party was originally trusted? For if the party to whom the goods are delivered was ever considered responsible, the engagement of the other is void, unless it is in writing; after earnest is given, the vender cannot sell the goods to another without a default in the vender, and therefore, if the vendee does not come and pay, and take the goods, the vender ought to give him notice for that purpose: then if he does not come and pay, and take away the goods in convenient time, the agreement is dissolved, and he is at liberty to sell them to any other person.

**SALEP**, or Salop. *See* Sago.

**SALET**, in War, a light covering for the head, anciently worn by the light horse. It was little more than a bare cap, but would resist a heavy blow.

**SALIANT**, in Fortification, projecting; as, a saliant angle.

**SALIC**, or Salique Law, *lex calica*, an ancient and fundamental law of the kingdom of France, usually supposed to have been made by Pharamond, or at least by Clovis, in virtue of which males only are to inherit. The ancient Romans allowed no sovereign women.

**SALIVA.** The fluid secreted in the mouth, which flows plentifully during a repast, is known by the name of saliva.

**SALIVATION**, in Medicine, a promoting of the flux of saliva by means of medicines, chiefly by mercury.

**SALIX**, the *Willow*, a genus of the diandria class of plants, and in the natural method ranking under the 50th order amentaceæ. There are 53 species.

**SALLYPORT**, a large port on each quarter of a fireship, out of which the officers and crew make their escape into the boats as soon as the train is fired.

**SALMO**, the *Salmon*, in Natural History, a genus of fishes of the order abdominales. Gmelin enumerates fifty-five species, and Shaw sixty-two, of which we shall notice the following: The common salmon. This abounds principally in the northern seas, which it quits at particular periods, to ascend rivers to a very considerable height, and deposit its spawn in them. In order to gain the favourite spots in rivers for this purpose, which are sometimes at the distance of several hundred miles from the ocean, these fishes will overcome difficulties of surprising extent, stemming the most rushing currents, and leaping with astonishing activity over various elevations. It is related that the same individual fishes will return to the same spot for a succession of seasons; in this respect exhibiting preferences similar to those of birds in similar circumstances.—The common trout is found in almost all the European streams, at least such as are cool and clear.—The red char is about a foot long, very similar in form to the common salmon, but more slender. It abounds in the rivers of Siberia, and the lakes of Germany; and in this country, in the lakes of Cumberland and Westmoreland. It is considered as one of the highest delicacies, and has the most brilliant colours and finest flavour, when inhabiting the coldest waters.—The smelt is about seven inches long, highly elegant, of a tapering form, and semi-transparent appearance. —The Greenland salmon. These abound off the coast of Greenland, where they are taken in vast quantities and dried, not only for the use of man but of cattle, for which they constitute a valuable food in winter. It is about the size of a smelt.—The grayling is about a foot and a half long, and abounds in the mountainous rivers in Europe and Asia. It resembles the trout in form. In some of the rivers of England, it is found in great perfection.

**SALON**, or Saloon, in Architecture, a very lofty spacious hall, vaulted at top, and sometimes comprehending two stories or ranges of windows.

**SALSOLA**, saltwort, kali, &c. a genus of the class and order pentandria digynia, and in the natural method ranking under the 12th order, holoraceæ. The species are thirty-one. This plant when burnt produces barilla.

**SALT**, Common. The preparation of that kind of salt which is used for culinary and economical purposes (muriate of soda) depends upon the well-known fact, that the salt contained in the sea water or brine springs, being a fixed body, will not rise with the vapour of the water. All therefore that is wanted is to expose any water containing salt to evaporation.

Salt *Marsh*, such pasture lands as lie near the sea, and are sometimes overflowed with the tides.

**SALTPETRE.** *See* Nitre.

**SALTPITS**, reservoirs on a coast, to contain sea-water for the purposes of making salt. The saltness of the sea, lakes, &c. is a thing that has long puzzled and perplexed philosophers to account for. The honourable Mr. Boyle believes it to be supplied not only from rocks and masses of salt, which at the beginning were, or in some countries may yet be found, either at the bottom of the sea, or at the sides, where the water can reach them, but also from the salt which the rivers, rains, and other waters, dissolve in their passage through divers parts of the earth, and at length carry with them into the sea. Buffon, and most modern philosophers, acquiesce in this opinion.

**SALTS**, in Chemistry, are all the crystallizable acids, or alkalies, or earths, or combination of acids with alkalies, earths, or metallic oxides.

**SALUTATION**, the act or ceremony of saluting, greeting, or paying respect or reverence to any one. In their modes of salutation, most nations have something peculiar.

**SALUTE**, a testimony of respect or of homage rendered by the ships of one nation to those of another, or by ships of the same nation to a superior or an equal. This ceremony is variously performed, according to the circumstances, rank, or situation of the parties: it consists in firing a certain number of cannon or volleys of small arms, in striking the colours or topsails, or in three general shouts of the whole ship's crew mounted upon the yards and rigging for that purpose.

Salute, the principal regulations with regard to salutes in the royal navy are as follow:—When a flag-officer salutes the admiral and commander-in-chief of the fleet, he is to give him fifteen guns; but when captains salute him, they are to give him seventeen guns; the admiral or commander-in-chief of the fleet, is to return two guns less to flag-officers, and four less to captains. Flag-officers saluting their superior or senior officer, are to give him thirteen guns. Flag-officers are to return an equal number of guns to flag-officers bearing their flags on the same mast, and two guns less to the rest, as also to captains. When a captain salutes an admiral of the white or blue, he is to give him fifteen guns; but to vice and rear admirals, thirteen guns. When a flag-officer is saluted by two or more of his majesty's ships, he is not to return the salute till all have finished, and then to do it with such a reasonable number of guns as he shall judge proper. In case of the meeting of two squadrons, the two chiefs only are to exchange salutes. And if single ships meet a squadron consisting of more than one flag, the principal flag only is to be saluted. No salutes shall be repeated by the same ships, unless there has been a separation of six months at least. None of his majesty's ships of war, commanded only by captains, shall give or receive salutes from one another in whatsoever part of the world they meet. A flag-officer, commanding in chief, shall be saluted upon his first hoisting his flag, by all the ships present, with such a number of guns as is allowed by the first, third, or fifth articles. When any of his majesty's ships shall meet with any ship or ships belonging to any foreign prince or state, within his majesty's seas, (which extend to Cape Finisterre,) it is expected that the said foreign ships do strike their topsail, and take in their flag, in acknowledgment of his majesty's sovereignty in those seas: and if any shall refuse, or offer to resist, it is enjoined to all flag-officers and commanders, to use their utmost endeavours to compel them thereto, and not suffer any dishonour to be done to his majesty. And if any of his majesty's subjects shall so much forget their duty, as to omit striking their topsail in passing by his majesty's ships, the name of the ship and master, and from whence, and whither bound, together with affidavits of the facts, are to be sent up to the secretary of the admiralty, in order to their being proceeded against in the admiralty court. And it is to be observed, that in his majesty's seas, his majesty's ships are in no ways to strike to any; and that in no other parts, no ship of his majesty is to strike her flag or topsail to any foreigner, unless such foreign ship shall have first struck, or at the same time strike her flag or topsail, to his majesty's ship. The flag-officers and commanders of his majesty's ships are to be careful to maintain his majesty's honour, upon all occasions, giving protection to his subjects, and endeavouring, what in them lies, to secure and encourage them in their lawful commerce; and they are not to injure, in any manner, the subjects of his majesty's friends and allies. If a foreign admiral meets with any of his majesty's ships and salutes them, he shall receive gun for gun. If he be a vice-admiral, the admiral shall answer with two guns less. If a rear-admiral, the admiral and vice-admiral shall return two less; but if the ship be commanded by a captain only, the flag-officers shall give two guns less, and captains an equal number. When any of his majesty's ships come to an anchor in a foreign port or road, within cannon-shot of its forts, the captain may salute the place with such a number of guns as have been customary, upon good assurance of having the like number returned, but not otherwise. But if the ship bears a flag, the flag-officer shall first carefully inform himself how flags of like rank belonging to other crowned heads have given or returned salutes, and to insist upon the same terms of respect. It is allowed to the commanders of his majesty's ships in foreign parts, to salute the persons of any admirals, commanders-in-chief, or captains of ships of war of foreign nations, of foreign noblemen, or strangers of quality; as also the factories of the king's subjects, coming on board to visit the ship; and the number of guns is left to the commander, as shall be suitable to the occasion and the quality of the persons visiting; but he is nevertheless to remain accountable for any excess in the abuse of this liberty. If the ship visited be in company with other ships of war, the captain is not to make use of the civilities allowed in the preceding articles, but with leave and consent of the commander-in-chief, or the senior captain. Merchant-ships, whether foreigners or belonging to his majesty's subjects, saluting the admiral of the fleet, shall be answered by six guns less; when they salute any other flag-ships, they shall be answered by four guns less; and if they salute men-of-war commanded by captains, they shall be answered by two guns less. If several merchant-ships salute in company, no return is to be made till all have finished, and then by such a number of guns as shall be thought proper; but though the merchant-ships should answer, there shall be no second return. None of his majesty's ships of war shall salute any of his majesty's forts or castles in Great Britain or Ireland, on any pretence whatsoever.

SALVAGE, a third part of the value of any thing recovered from the enemy, after having remained in his possession twenty-four hours, or of any thing dragged up from the bottom of the sea.

Salvage-*Money*, is a reward allowed by the civil and statute law, for the saving of ships or goods from the danger of the sea, pirates, or enemies. When any ship is in danger of being stranded or driven on shore, justices of the peace are to command the constables to assemble as many persons as are necessary to preserve it; and, on its being preserved by their means, the persons assisting therein shall, in thirty days after, be paid a reasonable reward for the salvage, otherwise the ship or goods shall remain in the custody of the officers of the customs as a security for the same.

SALVER, a flat dish, commonly of silver or other precious metal, used to set glasses on to serve wine and other liquors.

SALVIA, Sage, a genus of the monogynia order, in the dygynia class of plants, and in the natural method ranking under the 42d order, verticillatæ. There are 79 species.

SALVING Sheep, in rural economy, the dressing of them with tar and grease, against the scab and other diseases.

SAMARITANS, an ancient sect among the Jews, still subsisting in some parts of the Levant, under the same name.

SAMARRA, a garment worn by heretics condemned by the Inquisition to be burned. It is a kind of frock made of sackcloth, of a saffron colour, and painted with flames pointing downwards. Sometimes the unhappy victim's picture is drawn on it, with devils dragging him to perdition.

SAMBUCUS, Elder, a genus of the trigynia order, in the pentandria class of plants, and in the natural method ranking under the 43d order, dumosæ. The species are only five.

SAMIA TERRA, in the Materia Medica, an earth of the marl kind, found in the island of Samos, and much used both in medicine, and in the pottery of the ancients.

SAMIEL, the Arabian name of a hot wind peculiar to the desert of Arabia.

SAMP, a name given in some parts of America to a sort of bread, made of maize or Indian corn. It has been said, that those who feed on this sort of bread are never subject to the stone, and that they also escape many other disorders.

SAMPHIRE, a *Sea Weed*, found on land in the vicinity of the sea shore, and which is troublesome and difficult to extirpate.

Samphire, for pickling, is a herb generally found growing on cliffs near the sea. The vicinity of Dover is supposed to produce some of the best.

SAMPLE, of grain, seed, merchandise, &c is a small portion of any such articles as are to be sold, taken to market, or other places, for inspection, and as a specimen of the quality of the whole. The sample should never be superior to the aggregate which it represents.

SAMSON'S POST, a sort of pillar erected in a ship's hold, between the lower deck and the keelson, under the edge of a hatchway, and furnished with several notches, which serve as steps to ascend or descend. This post, being firmly driven into its place, not only serves to support the beam and fortify the vessel in that place, but also to prevent the cargo, or materials contained in the hold, from shifting to the opposite side by the rolling of the ship in a turbulent and heavy sea.

Samson's Post, is also the name of a strong piece of timber used on board ships of war, which being placed in a sloping position, with the upper end resting against a beam, serves, by means of a single block lashed near its middle, to form a return for a tackle-fall, and therefore affords space for a greater number of hands to clap on.

SANATADOS, a name given by the natives of Sicily to the spongy excrescence found on the stalk of the dog-rose. This, dried, and reduced to a powder, they use as an antidote against the effects of venomous bites. When a viper has inflicted a wound, the place having been scarified, is sprinkled over with this powder, and large doses are taken internally in strong wine. Softened into a poultice with oil, it is said to be efficacious in the bite of a mad dog; the powder, mixed with broth or weak fluids, being at the same time taken internally. In favour of this specific, the opinion is very old. Pliny says that the root of the wild rose, from the stalk of which this substance grows, was revealed in a dream, for the curing of this dreadful malady. The application is at least worth trying, the substance being very common, and to be procured without expense or difficulty

SANCTUARY, among the Jews, was the holiest and most retired place in the temple, in which was preserved the ark of the covenant, and into which no one was permitted to enter, except the high priest, and he only once a year.

Sanctuary, in our ancient customs, denotes an asylum or place, privileged by the prince, for the security of persons guilty of capital offences.

SAND, in Natural History, a genus of fossils, of great use in the glass manufacture: the white writing sand being employed for making the white glass, and a coarse greenish looking sand for the green glass. In agriculture it seems to be the office of sand to make unctuous earths fertile, and fit to support vegetables, &c. *See* Husbandry

Sand *Bags*, in the art of War, are bags filled with earth or sand, holding each about a cubic foot; their use is to raise parapets in haste, or to repair what is beaten down.

Sand *Flood*, a terrible mischief incident to the lands of Suffolk, and some other parts of England; which are frequently covered with vast quantities of sand, rolling in upon them like a deluge of water from sandy hills in their neighbourhood. The flowing of sand, though far from being so tremendous and hurtful as in Arabia, is of very bad consequences in this country, as many valuable pieces of sand has thus been entirely lost. The best mode of stopping these ravages is to plant the arundo arenaria, and other plants which take firm root in the sand.

SANDAL, a rich kind of slipper, made of gold, silk, or other precious stuff, and worn chiefly by the Greek and Roman ladies. It consisted of a sole, having an opening at one extremity to embrace the ancle, but leaving the upper part of the foot bare. Sandals are still worn in many countries, under many variations.

Sandal *Wood*, a beautifully coloured wood, hard, and fragrant in smell. It grows chiefly in India, and is valued for its medicinal virtues, and for inlaying in cabinet work.

SANDARACH, in Natural History, a very beautiful native fossil.

SANDARACH *Gum*, a resinous juice, which exudes from the trunks and thick branches of several kinds of juniper, in warm climates, and particularly on the coast of Africa, from incisions made in the bark. It has a light agreeable smell, and is sometimes used medicinally, but more generally in making varnishes.

SANDERLING, a small sprightly bird, found chiefly on the sea coasts. They are numerous on the shores of Cornwall.

SANDIVER, a whitish salt, continually cast up from the metal, as it is called, whereof glass is made; and swimming on its surface, is skimmed off.

SANDSTONE, in Mineralogy, is essentially composed of grains or particles of sand, either united by a mixture with other mineral substances, or adhering without any visible cement. The grains of sandstones are generally quartz, sometimes intermixed with felspar or slate.

SANGUIFICATION, in Physiology, the conversion into blood of the materials which supply the losses experienced by that fluid in nutrition, growth, secretion, and the other vital processes to which it is subservient.

SANGUINARIA, in Botany, a name suggested by the blood-coloured juice of the plant. Others, however, have derived the name from its efficacy in stopping hemorrhages.

SANGUINE, warm, bold, brisk, daring, abounding in blood.

SANGUINE *Stone*, a kind of jasper, brought from New Spain, of a dark brown colour, marked with spots of a blood-red. It is sometimes called blood-stone from its supposed virtue to stanch blood, either when applied to the affected part, having been first dipped in water, or by the patient grasping it in his hand.

SANHEDRIM, among the ancient Jews, the supreme council court, or court of judicature, in which were despatched all great affairs both of religion and civil policy.

SANIDIUM, in Natural History, a genus of fossils in the class of the selenitæ.

SANIES, in Medicine, a serous putrid matter, issuing from wounds; it differs from pus, which is thicker and white.

SANQUA, in Botany, a shrub nearly resembling tea, and found in Japan. Its leaves, when dried, yield a fragrant smell. The Japanese females use the decoction for washing their hair. Thunberg says, the leaves are sometimes mixed with tea, to increase its odour.

SANTEO, in Botany, a name given by the people of Guinea to an herb, which being boiled in water, communicates a virtue to the fluid, that cures diseases in the eyes when washed with it.

SAP. The sap of plants, in general, is very compound in its nature; and contains most saccharine, mucilaginous, and albuminous matter in the alburum; and most tannin and extract in the bark. The cambium, which is the mucilaginous fluid found in trees between the wood and the bark, and which is essential to the formation of new parts, seems to be derived from these two kinds of sap; and probably is a combination of the mucilaginous and albuminous matter of one with the astringent matter of the other, in a state fitted to become organized by the separation of its watery parts.

SAP, or SAPP, in the art of War, is the digging deep under the earth of the glacis, in order to open a covered passage into the moat.

SAP-*Colours*, a name given to various expressed juices of a viscid nature, which are inspissated by slow evaporation for the use of painters; as sapgreen, gamboge, &c.

SAPANARIA, a name given to several plants, because the leaves being bruised yields a substance producing a lather like soap.

SAPPHIRE. Telesia of Hauy and corundum of Bournon. A valuable mineral of a beautiful blue or red colour, sometimes white, green, and yellow. After the diamond it is the hardest substance in nature. The constituents of the blue sapphire, according to Klaproth, are 92·5 alumina, 6·5 lime, and oxide of iron.

SAPINDUS, or INDIAN SOAP, the acrid rind of the fruit serving instead of soap, but not without hazard of injuring the texture of the cloth.

SAPONACEA TERRA, is a kind of native alkali, of the nitre found on the surface of the earth, mixed with dirt, &c. in the vicinity of Smyrna; and hence sometimes called Smyrna earth. It boils up apparently out of the ground, and presents itself as a fine whitish salt. With other ingredients it is made into soap, and applied to other purposes.

SARABANDE, a dance said to be originally derived from the Saracens. The tune of the sarabande is both expressive and majestic.

SARCASM, in Rhetoric, a keen bitter expression, which has the true point of satire, by which the orator scoffs and insults his enemy; such was that of the Jews to our Saviour, "He saved others, himself he cannot save."

SARCOCOLL, a vegetable substance intermediate between sugar and gum, partaking in some measure of the properties of each, but certainly approaching nearer to sugar than to gum.

SARCOPHAGUS, a sort of stone coffin or grave, in which the ancients interred those whom they did not burn. The stone of which these receptacles were originally made, resembled a reddish pumice-stone. It had a saltish taste, and was reported to decompose every portion of the body, excepting the teeth, in about forty days.

SARDACHATES, a species of agate, frequently found on the margins of rivers in the East Indies.

SARDIAN, a precious stone, of a blood colour, semitransparent, and sometimes called carnelian.

SARDOA, a poisonous plant, which grows plentifully in Sardinia, sometimes called water crowfoot.

SARDONYX, a precious stone consisting of a mixture of the chalcedony and carnelian, sometimes in strata, but at other times blended together.

SARISSA, a long spear used by the Macedonians.

SARON, in Greek Mythology, the particular god that presided over sailors.

SAROS, a period of 223 lunar months.

SARPLAR OF WOOL, a quantity of wool, called sometimes a pocket, or half sack. A sack contains eighty tods, a tod two stones, and a stone fourteen pounds.

SARRASIN, in Fortification, a kind of portcullis, otherwise called a herse, hung with ropes over the gates of a town or fortress, and let fall in case of a surprise.

SARSAPARILLA, in Pharmacy, the root of the rough smilax of Peru, consisting of a great number of long strings hanging from one head; these long roots, the only parts made use of, are about the thickness of a goose quill, or thicker, flexible, and composed of fibres running their whole length; they have a bitterish, but not ungrateful taste, and no smell; and as to their medicinal virtues, they are sudorific and attenuant, and should be given in decoction, or by way of diet-drink.

SASHES, in Military language, are badges of distinction worn by officers, either over the shoulders or round the waist. They are made of crimson silk.

SASSAFRAS, in Pharmacy, the wood of an American tree of the laurel kind, imported in large straight blocks; it is said to be warm, aperient, and corroborant; and is frequently employed, with good success, for purifying the blood, for which purpose an infusion, in the way of tea, is a very pleasant drink; its oil is very fragrant, and possesses most of the virtues of the wood.

SASSOLIN, in Mineralogy, concrete native boracic acid, so called from being found on the banks of a hot spring at Sasso, in Italy.

SATELLITIAN MACHINE, a machine by which the motions of the satellites, or secondary planets, are produced by wheel work, in the same way that the motions of the primaries are effected by a planetarium. Several such machines have been invented.

SATELLITE, a secondary planet moving round another planet, as the moon round the earth.

SATIN SPAR, fibrous limestone.

SATIN, a kind of silken stuff, very smooth and shining. The woof is coarse, and hidden underneath the warp, which is fine, and stands out, and on this depends its gloss and beauty, which give its value and price. The finest satins are said to be at Florence and Genoa. Chinese satins, richly embroidered, were once in high estimation, but our own manufactures are at present equal in most respects to the foreign. The colours and flowers are various, and the price is regulated accordingly.

SATIRE, any discourse in which a person is reprehended; but more particularly a poem in which the follies and vices of persons are wittily exposed in order to their reformation.

**SATISFACTION**, in Law, a recompense made for an injury done, or the payment of money due on bond, judgment, or bill.

**SATRAPA**, or Satrapes, in Persian Antiquity denotes an admiral, but more commonly the governor of a province.

**SATURATION.** Some substances unite in all proportions. Such, for example, as acids in general, and some other salts with water; and many of the metals with each other. But there are likewise many substances which cannot be dissolved in a fluid, at a settled temperature, in any quantity beyond a certain proportion. Thus water will dissolve only about one-third of its weight of common salt, and, if more be added, it will remain solid. A fluid which holds in solution as much of any substance as it can dissolve, is said to be saturated with it. But saturation with one substance does not deprive the fluid of its power of acting on and dissolving some other bodies, and in many cases it increases this power. For example, water saturated with salt will dissolve sugar; and water saturated with carbonic acid will dissolve iron, though without this addition its action on this metal is scarcely perceptible. The word saturation is likewise used in another sense by chemists: the union of two principles produces a body, the properties of which differ from those of its component parts, but resemble those of the predominating principle. When the principles are in such proportion that neither predominates, they are said to be saturated with each other; but if otherwise, the more predominant principle is said to be sub-saturated or under-saturated, and the other super-saturated or over-saturated.

**SATURN.** *See* Astronomy.

**SATURNALIA**, feasts celebrated among the Romans, in honour of Saturn, in which riot and debauchery prevailed among all ranks. M. Dacier observes, that the Saturnalia were not merely to honour Saturn, but to keep in remembrance the golden age, when all mankind were on a level.

**SATYR**, in Mythology, a fabulous kind of demigod, who, with the fawns and sylvans, presided over groves and forests, under the direction of Pan.

**SAUCER of a Capstan**, is a socket of iron let into a wooden stock or standard, called the step, resting upon and bolted to the beams. Its use is to receive the spindle or foot on which the capstan rests and turns round.

**SAUCISSE**, in the Military art, is a long train of powder sewed up in a roll of pitched cloth or leather, serving to set fire to mines. To every mine there are generally two, that if one fail, the other may take effect. Their length is determined by circumstances.

**Saucisson**, in Fortification, a kind of faggot made of thick branches of trees, bound together, to cover the men while exposed to the enemy's fire, when on some hazardous employment. It is also used to repair breaches, stop passages, and make traverses over wet ditches.

**SAVINE.** *See* Juniper.

**SAVIOUR**, Order St. a religious order in the Romish church, founded by St. Bridget, about the year 1345; and so called from its being pretended that our Saviour himself dictated to the foundress its constitutions and rules.

**SAVORY**, in Botany, a plant, of which the leaves are warm aromatic, of a grateful smell, and pungent to the taste. There are two kinds, the winter and summer savory.

**SAW**, an instrument which serves to cut into pieces several solid matters; as wood, stone, ivory, &c.

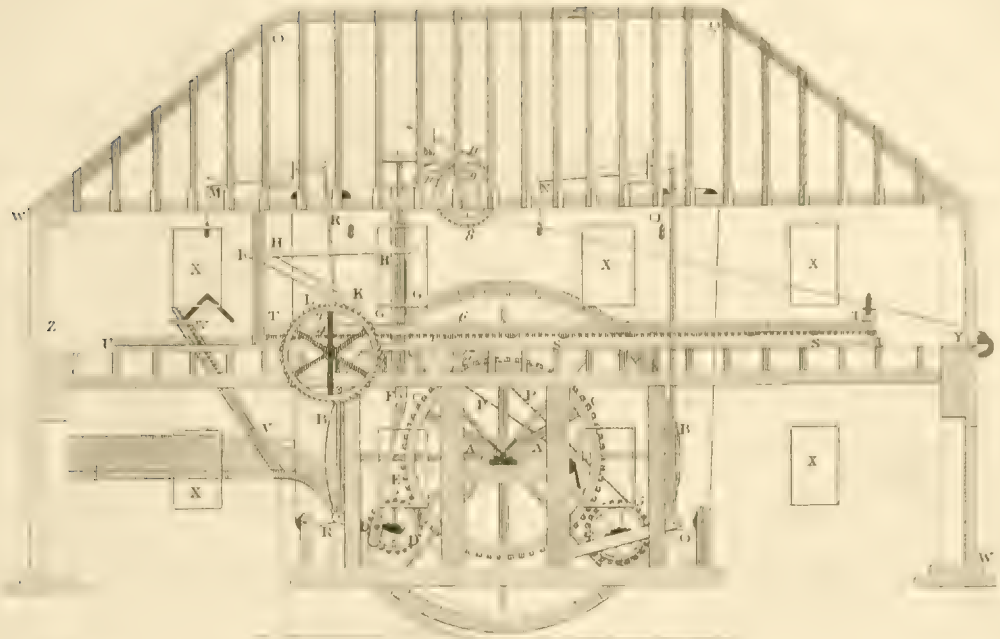
**SAW MILLS**, constructed for the purpose of sawing either timber or stone, are moved by animals, by water, by wind or, by steam. They may be divided into two kinds: 1st, those by which the motion of the saw is reciprocating; and 2dly, those in which the saws have a rotatory motion. Reciprocating saw mills for cutting timber, and moved by water, do not exhibit much variety in their construction. Fig. 1, in the plate shews the sectional elevation of a saw mill taken from Gray's Experienced Millwright. A A the shaft or axle, upon which is fixed the wheel B B, of 17½ or 18 feet diameter, containing 40 buckets to receive the water which impels it round. C C a wheel fixed upon the same shaft containing 96 teeth, to drive the pinion No. 2, having 22 teeth, which is fastened upon an iron axle or spindle, having a coupling box on each end, that turns the cranks, as D D, round. One end of the pole E is put on the crank, and its other end moves on a joint or iron bolt at F in the lower end of the frame G G. The crank D D being turned round in the pole E moves the frame G G up and down, and these having saws in them, by this motion cut the wood. The pinion. No. 2, may work two, three, or more cranks, and thus move as many frames of saws. No. 3, an iron wheel having angular teeth, which one end of the iron K takes hold of, while its other end rolls on a bolt in the lever H H. One end of this lever moves on a bolt at I, the other end may lie in a notch in the frame G G, so as to be pushed up and down by it. Thus the catch K pulls the wheel round, while the catch L falls into the teeth, and prevents it from going backwards. (*See* Universal Lever.) Upon the axle of No. 3, is also fixed the pinion No. 4. taking into the teeth in the under edge of the iron bar that is fastened upon the frame T T, on which the wood to be cut is laid; by this means the frame T T is moved on its rollers S S, along the fixed frame U U; and of course the wood fastened upon it is brought forward to the saws as they are moved up and down by reason of the turning round of the crank D D. V V, the machine and handle to raise the sluice when the water is to be let upon the wheel B B to give it motion. By pulling the rope at the longer arm of the lever M, the pinion No. 2, is put into the hold or grip of the wheel C C, which drives it; and by pulling the rope R, this pinion is cleared from the wheel. No. 5. a pinion containing 24 teeth driven by the wheel C C, and having upon its axle a sheave, on which is the rope P P, passing to the sheave No. 6, to turn it round; and upon its axle is fixed the pinion No. 7, acting on the teeth in an iron bar upon the frame T T, to roll that frame backwards when empty. By pulling the rope at the longer arm of the lever N, the pinion, No. 5, is put into the hold of the wheel C C; and by pulling the rope O it is taken off the hold. No. 8, a wheel fixed upon the axle No. 9, having upon its periphery angular teeth, into which the catch No. 10, takes: and being moved by the lever attached to the upper part of the frame G, it pushes the wheel No. 8, round; and the catch No. 11. falls into the teeth of the wheel, to prevent it from going backwards, while the rope rolls in its axle, and drags the logs or pieces of wood in at the door Y, to be laid upon the moveable frames T T, and carried forward to the saws to be cut. The catches No. 10, 11, are easily thrown out of play when they are not wanted. The gudgeons in the shafts, rounds of the cranks, spindles and pivots, should all turn round in cods or bushes of brass. Z a door in one end of the mill-house, at which the wood is conveyed out when cut. W W, walls of the mill-house. Q Q, couples or framing of the youth. X X X, &c. windows to admit light to the house.

2. Sawmills for cutting blocks of stone are generally, though not always, moved horizontally; the horizontal alternate motion may be communicated to one or more saws by means of a rotatory motion, either by the use of cranks, &c. or in some such way as the following. Let the horizontal wheel A, B, D, C, fig. 2, drive the pinion O *p* N, this latter carrying a vertical pin P, at the distance of about ⅓ of the diameter from the centre. This pinion and pin are represented separately in fig. 3. Let the frame W S T V, fig. 2, carrying four saws, marked 1, 2, 3, 4, have wheels V, T, W, W, each running in a groove or rut, whose direction is parallel to the proposed direction of the saws; and let a transverse groove P R, whose length is double the distance of the pin P from the centre of the pinion, be cut in the saw frame to receive that pin. Then as the great wheel revolves, it drives the pinion, and carries round the pin P; and this pin, being compelled to slide in the straight groove P R, while by the rotation of the pinion on which it is fixed its distance from the great wheel is constantly varying, it causes the whole saw frame to approach to and recede from the great wheel alternately, while the grooves in which the wheels run confine the frame so as to move in the direction T *t*, V *v*. Other blocks of stone may be sawn at the same time by the motion of the great wheel, if other pinions and frames running off in the directions of the respective radii E B, E A, E C, be worked by the teeth at the quadrantal points B, A, and C. And the contrary efforts of these four frames and pinions will tend to soften down the jolts, and equalize the whole motion. The same contrivance of a pin fixed at a suitable distance from the centre of a wheel, and sliding in a groove, may serve to convert a reciprocating into a rotatory motion; but it will not be preferable to the common conversion by means of a crank.

# Saw Mills

P.211

Fig 1.



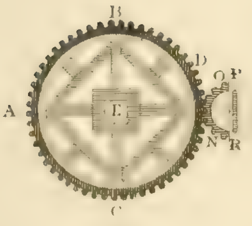


Fig 2

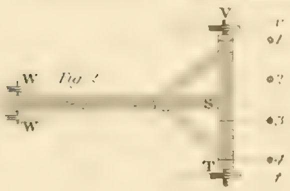


Fig 3

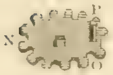


Fig 6

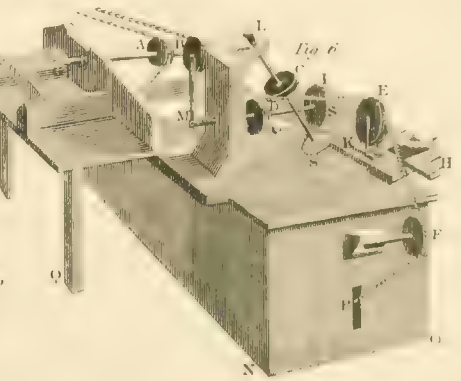


Fig 9

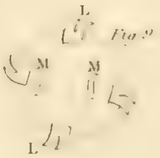


Fig 10

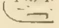


Fig 4

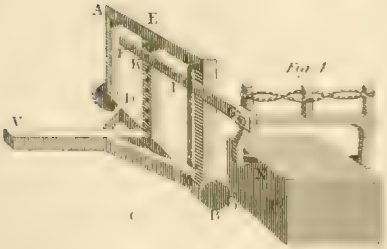


Fig 5

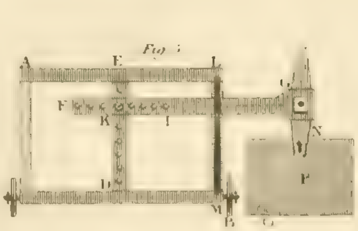


Fig 8

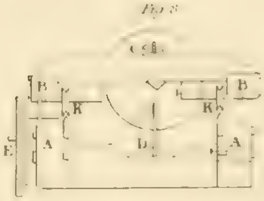
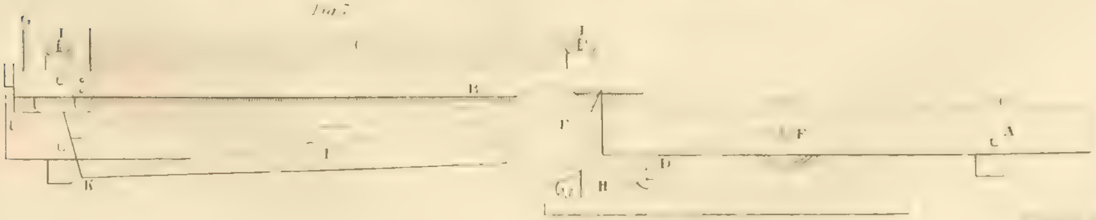


Fig 7



3. When saws are used to cut blocks of stone into pieces having cylindrical surfaces, a small addition is made to the apparatus. See figs. 4 and 5. The saw, instead of being allowed to fall in a vertical groove as it cuts the block, is attached to a lever or beam F G, sufficiently strong: this lever has several holes pierced through it, and so has the vertical piece ED, which is likewise moveable towards either side of the frame in grooves in the top and bottom pieces A L, D M. Thus the length K G of the radius can be varied at pleasure, to suit the curvature of N O; and as the saw is moved to and fro by proper machinery in the direction C B, B C, it works lower and lower in the block, while being confined by the beam F G, it cuts the cylindrical portion from the block P as required.

When a completely cylindrical pillar is to be cut out of one block of stone, the first thing will be to ascertain in the block the position of the axis of the cylinder; then lay the block so that such axis shall be parallel to the horizon, and let a cylindrical hole of from one to two inches diameter be bored entirely through it. Let an iron bar whose diameter is rather less than that of this tube, be put through it, having just room to slide freely to and fro as occasion may require. Each end of this bar should terminate in a screw, on which a nut and frame may be fastened; the nut frame should carry three flat pieces of wood or iron, each having a slit running along its middle nearly from one end to the other, and a screw and handle must be adapted to each slit; by these means the frame work at each end of the bar may readily be so adjusted as to form equal isosceles or equilateral triangles; the iron bar will connect two corresponding angles of these triangles, the saw to be used two other corresponding angles, and another bar of iron and of wood the two remaining angles, to give sufficient strength to the whole frame. This construction, it is obvious, will enable the workmen to place the saw at any proposed distance from the hole drilled through the middle of the block; and then by giving the alternating motion to the saw frame, the cylinder may at length be cut from the block, as required. This method was first pointed out in the Collection of Machines approved by the Paris academy. If it were proposed to saw a conic frustum from such a block, then let two frames of wood or iron be fixed to those parallel ends of the block which are intended to coincide with the bases of the frustum, circular grooves being previously cut in these frames, to correspond with the circumferences of the two ends of the proposed frustum; the saw being worked in these grooves will manifestly cut the conic surface from the block. This, we believe, is the contrivance of Sir George Wright.

The best method of drilling the hole through the middle of the proposed cylinder seems to be this: on a carriage running upon four low wheels let two vertical pieces (each having a hole just large enough to admit the borer to play freely) be fixed two or three feet asunder, and so contrived that the pieces and holes to receive the borer may, by screws, &c. be raised or lowered at pleasure, while the borer is prevented from sliding to and fro by shoulders upon its bar, which are larger than the holes in the vertical pieces, and which, as the borer revolves, press against those pieces: let a part of the boring bar between the two vertical pieces be square, and a grooved wheel with a square hole of a suitable size be placed upon this part of the bar, then the rotatory motion may be given to the bar by an endless band which shall pass over this grooved wheel and a wheel of a much larger diameter in the same plane, the latter wheel being turned by a winch handle in the usual way. As the boring proceeds, the carriage with the borer may be brought nearer and nearer the block, by levers and weights, in the same manner as is described under the article *Boring of* ORDNANCE.

4. Circular saws, acting not by a reciprocating but by a rotatory motion, have been long known in Holland, where they are used for cutting wood wanted in veneering. They were introduced into this country, we believe, by General Bentham, and are now used in the dock-yard at Portsmouth, the Royal Arsenal, Woolwich, and in a few other places: but they are not, as yet, so generally adopted as might be wished, considering how well they are calculated to abridge labour, and to accomplish with expedition and accuracy what is very tedious and irksome to perform in the usual way. Circular saws may be made to turn either in horizontal, vertical, or inclined planes; and the timber to be cut may be laid upon a plane inclined in any direction; so that it may be sawn by lines making any angle whatever, or at any proposed distance from each other. When the saw is fixed at a certain angle, and at a certain distance from the edge of the frame, all the pieces will be cut of the same size, without marking upon them by a chalked line, merely by causing them to be moved along and keeping one side in contact with the side of the frame; for then, as they are brought one by one to touch the saw revolving on its axle, and are pressed upon it, they are soon cut through.

Mr. Smart, of Ordnance Wharf, Westminster-bridge, has several circular saws, all worked by a horse in a moderate sized walk: one of these, intended for cutting and boring tenons used in this gentleman's hollow masts, is represented in fig. 6. N O P Q R is a hollow frame, under which is part of the wheel-work of the horse-mill.—A, B, D, C, E, F, are pulleys, over which pass straps or endless bands, the parts of which out of sight run upon the rim of a large vertical wheel: by means of this simple apparatus, the saws S, $S'$, are made to revolve upon their axles with an equal velocity, the same band passing round the pulleys D, C, upon those axles; and the rotatory motion is given to the borer G by the band passing over the pulley A. The board I is inclined to the horizon in an angle of about 30 degrees; the plane of the saw $S'$ is parallel to that of the board I, and about ¼ of an inch distant from it, while the plane of the saw S is vertical, and its lowest point at the same distance from the board I. Each piece of wood K out of which the tenon is to be cut is four inches long, an inch and a quarter broad, and ⅜ of an inch thick. One end of such piece is laid so as to slide along the ledge at the lower part of the board I; and as it is pushed on by means of the handle H, it is first cut by the saw $S'$, and immediately after by the saw S: after this the other end is put lowest, and the piece is again cut by both saws; then the tenon is applied to the borer G, and as soon as a hole is pierced through it, it is dropped into the box beneath. By this process, at least 30 tenons may be completed in a minute, with greater accuracy than a man could make one in a quarter of an hour, with a common handsaw and gimblet. The like kind of contrivance may, by slight alterations, be fitted for many other purposes, particularly all such as may require the speedy sawing of a great number of pieces into exactly the same size and shape. A very great advantage attending this sort of machinery is, that, when once the position of the saws and frame is adjusted, a common labourer may perform the business just as well as the best workman.

Mr. Brunel, a well-known civil engineer, took out a patent for saw-machinery, in May, 1805. The following is an abridgment of his specification. The saws are circular, and turn upon an axis passing through their centre. When they are too large to be made with sufficient strength of only one piece of steel, they may be constituted of two, four, eight, &c. pieces, and the joining edge of one plate must be hollow, to receive the sharp edge of that which is to be fitted into it. To augment the strength of the plates, flanches may be closely fitted to them, several pieces of leather or of paper being interposed, by means of which, and screws duly applied, the whole may be made very firm and strong. The improvements in the machinery for sawing timber easily and expeditiously, consist in the modes of laying and holding the piece of wood in the carriage or drag, in the facility of shifting the saw from one cut to another, and in the practicability of sawing both ways either towards or from the saw or saws. Each circular saw is adjusted upon a cylindrical spindle, which turns within rodings; the motion being communicated by means of a strap or band turning about a proper drum-wheel, and moved by any of the usual actuating powers, as wind, water, steam, animals, &c. The piece of timber being placed upon a drag or carriage, is held fast by means of clamps; and the carriage is moved towards and from the saw by a handle or crank communicating, by the assistance of cog-wheels, to a pinion which engages in a horizontal rack running under the frame of the carriage. This carriage is furnished with rollers serving to ease its longitudinal motion, and is intended to be moved by hand, so that its velocity may be varied at pleasure: the length of this carriage must obviously be proportionate to the size of the timber generally cut by the saw. After the saw has performed one cut, instead of moving the timber, the saw itself is moved sidewise, that is, in the direction of its axle, by means of screws, after a method which may be easily conceived, till it is brought to the proper position for the next cut, when an adjusting or fixing screw prevents any lateral motion, and the rotary motion of the saw, and the rectilinear motion of the wood, may be resumed. Circular wedges are used, being intended to revolve by the motion of the log to follow the cut opened by the saw, and by that means to ease the friction, and steady the piece of timber. Sometimes an instrument composed of several parallel plates of metal may be employed instead of the circular wedges. When several saws are adjusted on one spindle, a piece of timber may be converted into planks by being drawn once through under the saws. In that case the flanches of the saws are fixed upon an iron drum, and kept firmly in their relative parallel positions by four bolts. In order to lower the saws as they wear away, the side rails sustaining their axles may be depressed by means of wedges. The log of wood is not to lie close upon the carriage or drag, but upon some transverse pieces, which may be moved if requisite when they come near the saw. Some very complete and extensive saw-mills have been recently erected by Mr. Brunel, in the carriage department of the Royal Arsenal, Woolwich, under the superintendence of Major-General Cuppage and Colonel Miller. Among the numerous purposes for which saws are employed, is that of cutting off the tops of piles. When these are below water, some additional mechanism is necessary to cause the saws to work in a horizontal plane at a suitable depth. Different contrivances for this purpose, with illustrative engravings, are described by M. Hachette, *Traité des Machines*, p. 252--275.

Saw-Mills are of greater antiquity than is generally supposed. So early as the fourth century, a saw-mill was erected on the small river Roeur, in Germany: it is probable, however, that this was but a rude contrivance, as we find writers of more modern times, speaking of saw-mills as new and uncommon. The old construction had therefore very likely been lost, or the improvement was so great, as to cause the more modern to be looked upon as new inventions. Saw-mills have been in use more than four hundred years, for upon the discovery of Madeira in 1420, mills were erected there for sawing the various excellent timber with which the island abounded. The city of Breslaw had a saw-mill in 1427, which produced a yearly rent of three marks. Erfurt had a saw-mill in 1490. In Norway the first saw-mill was built in 1530. Soon after, the first saw-mill was built in Holstein, another at Joachimstall. In 1555, the Bishop of Ely, ambassador from Queen Mary to the court of Rome, having seen a saw-mill at Lyons, it was thought worthy of a particular description. It was not, however, until the sixteenth century that saw-mills received the great improvement of having several different saw blades, by which a piece of timber was cut into many planks at the same time. At Saardam, in Holland, were erected a number of saw-mills, where a great many still remain, notwithstanding more than a hundred have been given up of late years. The largest saw-mill ever constructed is in Sweden, where a water-wheel, twelve feet in breadth, drives, at the same time, no less than seventy-two saws. In the seventeenth century, saw-mills were introduced into England, attended with the most violent opposition from the sawyers, who apprehended that they would be the means of depriving them of their subsistence. Some that were undertaken were abandoned at the onset, and others were destroyed by the populace. The saw-mills of the present day are of two distinct kinds; the circular, those that cut by a continuous rotary motion, and the reciprocating, which operate as the common pit or frame saw. The circular saw-mills are for the most part used for cutting up timber of small dimensions; and the reciprocating for large timber, in forming beams, rafters, planks, &c. out of large timber. The most important machinery of the kind was erected by Brunel, under the joint co-operation of Dr. Gregory, at Portsmouth.

*Eastman's Improved* SAW-MILL.—Some important improvements have recently been made by Robert Eastman, of Brunswick Maine, United States, in sawing machines; the distinguishing features of which consist in a rotary saw of a superior construction to the common circular saw, and in the improved manner in which the logs are sawn. Instead of a continued series of teeth round the periphery of the plate like other circular saws, Eastman's has only eight, or rather only four cutting instruments (each containing two teeth) placed at equal distances on the circumference, and projecting from it; these instruments are called section teeth. The saving of labour is calculated at full three-fourths, and the surface of the timber is smoother than when cut by the full-teethed saw. On the saw plate are fixed instruments called sappers, which being placed nearer to the centre, do not enter the wood so deeply as the saw, and are adjusted so as merely to cut off the extraneous sap part, rendering the edges of the planks uniformly straight, and all the cuts of equal dimensions. To understand which, it is, perhaps, necessary here to explain to the reader that the logs are by this machinery cut up lengthwise, not through the log, but from the circumference or exterior to the centre, as the radii of a circle; it having been ascertained that planks cut in this manner possess more durability, strength, and elasticity, than by the common method.

Fig. 7, in the plate, represents a side view of the machine, with a log in it ready for working. Fig. 8, is an end view of the same, exhibiting the log partly cut into sections. Fig. 9, is the saw, with its section teeth L L L L, and its sappers M M. Fig. 10, shews the shape of the sapper, with a groove, or slit, to admit of its being set according to the intended width of the plank.

A, fig. 7, is a strong frame of timber, about twenty-four feet long by five broad, the ends of which are seen at A A, fig. 8. B, fig. 7, is the carriage, about twelve feet long and four broad, the ends of which are seen at B B, fig. 8; it travels upon iron truck-wheels, grooved on their circumferences, and run upon iron slides, as shewn at K K, fig. 8. C, figs. 7 and 8, gives two views of the log under operation. The log is fixed into the carriage by means of iron centres, upon which it also revolves after each succeeding cut. At D D, figs. 7 and 8, is seen part of the saw. At E E, figs. 7 and 8, are situated the feed pulley and shifting gear. F, regulating pulleys. G, is an index for regulating the dimensions of the cuts. H, revolving levers and pins. I, the pin and fulcrum of the levers. J J, the stirrup screws and pins. Nearly in the middle of the frame is fixed the main shaft, (of cast iron,) which runs upon friction rollers, supported by stands on the floor. On this shaft is the saw with its sappers and section teeth. The motion is given by a band passing round the main pulley, and round a drum that runs under it; which may be driven by horse, steam, or water power. The method by which the saw is fed with the wood to be cut, and the return of the carriage for the succeeding cut, is too similar to our own to need a particular description. Its various arrangements are ingeniously contrived, and it may be justly termed a self-acting machine, for when once set in motion, no other aid, than the power which drives it, is requisite to its cutting a whole series of boards of uniform dimensions all round the log, having their thin-edged sides attached to the centre piece. These boards being removed, a second series of boards may be cut in like manner to the former, provided the log is big enough.

This machine furnishes a new method of manufacturing lumber for various useful purposes. Though the circular saw had previously been in operation in this country, and in Europe, for cutting small stuff, it had not, with the knowledge of the writer, been successfully applied to solids of great depth; to effect which, the use of section teeth are almost indispensable. In his first attempts to employ the circular saw for the purpose of manufacturing clap boards, Eastman used one nearly full of teeth, for cutting five or six inches in depth into fine logs. The operation required a degree of power almost impossible to be obtained with the use of a band; the heat caused the plate to expand, and the saw to warp, or as it is termed, 'to get out of true.' To obviate these difficulties, he had recourse to the use of section teeth, and the improvement completely succeeded. The power required to perform a given quantity of work by the other method, was by this diminished at least three-quarters. The work, formerly performed by seventy or eighty teeth, was, by the last method, performed by eight teeth; the sawdust, which before had been reduced to the fineness of meal, was coarser, but the surface of the lumber much smoother than when with the full-teethed saw. The teeth are made in the form of a hawk's bill, and cut the log up, or from the circumference to the centre. The saw may be carried by an eight-inch band, and when driven a proper speed (which is from ten to twelve hundred times per minute) will cut nine or ten inches in depth into the hardest white oak timber with the greatest ease. The sappers at the same time cut off from one to two inches of the sap, and straighten the thick edges of the lumber. The facility with which this saw will cut into such hard materials, may be supposed to result from the well-established principle, that where two substances in motion come in contact, their respective action on each other is in direct proportion to their respective velocities; thus a circular plate of iron put into a quick rotary motion, will with great ease penetrate hardened steel, or cut through a file when applied to its circumference; and the same principle is applicable to a saw for cutting wood. The requisite degree of velocity is obtained by the continuous motion of the circular saw; by which also it has greatly the advantage of one that has but a slow motion on account of dulling, as the teeth are but little affected, and being only eight in number, but a few moments' labour is required to sharpen them. If the velocity of the saw were slackened to a speed of but forty or fifty times per minute, it would require at least four such bands to carry it through a log as above described. One machine will cut from eighteen to twenty hundred of square feet of pine timber per day, and two of them may be driven by a common tub wheel, seven or eight feet in diameter, having six or seven feet head of water, with a cog-wheel and trundlehead, so highly geared as to give a quick motion to the drums, which should be about four feet in diameter. The machine is so constructed as to manufacture lumber from four to ten feet in length, and from two to ten inches in width, and of any thickness. It has been introduced into most of the New England states, and has given perfect satisfaction. The superiority of the lumber has for three years past been sufficiently proved in Brunswick Maine, where there have been annually erected from fifteen to twenty wooden buildings, and for covering the walls of which this kind has been almost universally used. The principal cause of its superiority to mill-sawed lumber, is in the manner in which it is manufactured, viz. in being cut towards the centre of the log, like the radii of a circle; this leaves the lumber feather-edged in the exact shape in which it should be, to set close on a building, and is the only way of the grain, in which weather-boards of any kind can be manufactured to withstand the influence of the weather, without shrinking, swelling, or warping off the building. Staves and heading, also, must be rived the same way of the grain, in order to pass inspection. The mill-sawed lumber, now universally used in the middle and southern states, and in the West Indies, for covering the walls of wooden buildings, is partly cut in a wrong direction of the grain, which is the cause of its cracking and warping off, and of the early decay of the buildings by the admission of moisture. That such is the operation, may be inferred by examining a stick of timber which has been exposed to the weather; the cracks caused by its shrinking all tend towards the heart or centre, which proves that the shrinking is directly the other way of the grain. It follows that lumber cut through or across the cracks, would not stand the weather in a sound state, in any degree to be compared with that which is cut in the same direction with them. One half the quantity of lumber manufactured in this way, will cover and keep tight and sound the same number of buildings for a hundred years, that is now used and consumed in fifty years. Add to this the reduction of expense in transportation, and of labour in putting it on, and we think every one must be convinced that the lumber manufactured in this improved way is entitled to the preference. In manufacturing staves and heading, a great saving is made in the timber, particularly as to heading, of which at least double the quantity may be obtained by this mode of sawing, to what can be procured in the old method of riving it; nor is the straight-grained, or good rift, indispensable for the saw, as it is for the purpose of being rived. The heading, when sawed, is in the form it should be, before it is rounded and dowelled together, all the dressing required being merely to smooth off the outsides with a plane. Timber for staves ought to be straight in order to truss, but may be manufactured so exact in size, as to require but little labour to fit them for setting up. Both articles are much lighter for transportation, being nearly divested of superfluous timber, and may be cut to any thickness required for either pipes, hogsheads, or flour barrels.

SAY, or Saye, in Commerce, a kind of serge or woollen stuff, much used abroad for linings, and by the religious for shirts. It is often dyed green, and used for workmen's aprons.

SCAFFOLD, a timber work raised in the manner of an amphitheatre, to afford a good view of the object or company.

Scaffold, is also the name of a stage raised for the execution of criminals. It is likewise an elevated temporary assemblage of poles and boards, to enable builders to attend to their work, in the erection of walls, roofs, &c.

SCAGLIOLA, an imitation of marble of any sort. It is hard, and when finished bears a fine polish. It is laid on brickwork like stucco, and worked off with iron tools. The Pantheon, in Oxford-street, London, had all its columns formed of this material; and when first done, they could scarcely be distinguished from real marble. If preserved from accident, this composition will retain its lustre for many years, without any considerable change of colour, or diminution of beauty.

SCALDED CREAM, in rural economy, such cream as is raised by a gentle heat. It is usually called clotted or clouted cream, and is chiefly made in Devonshire and Cornwall, in which counties it is much esteemed. The process is simple. The milk is put into a wide shallow pan, and after standing in it a few hours, the pan is placed over a clear but gentle fire. The cream then collects on the surface, and as the milk gets near boiling, it is taken off and left to cool. The cream is then skimmed off, and preserved for butter or other uses.

SCALE, a mathematical instrument, consisting of several lines, drawn on wood, brass, silver, &c. and variously divided according to the purposes it is intended to serve; whence it acquires various denominations, as the plain scale, diagonal scale, plotting scale, Gunter's scale, &c.

Scale, in Music, the denomination first given to the arrangement made by Guido, of the six syllables, ut, re, mi, fa, sol, la; also called Gamut.

SCALES, in Natural History, the covering of fishes, serpents, lizards, &c. They are of various kinds, and seem to possess properties analogous to the horns and hoofs of animals. This is indicated by their properties being analyzed, their being cut, and their smell when burned.

Scales, in Commerce, boards or metallic plates, suspended at the extremities of a beam, for weighing various articles, in order to ascertain their specific gravity and value.

SCALENE, a triangle, whose sides and angles are all unequal.

SCALING, the act of cleaning the inside of a ship's cannon by the explosion of a small quantity of powder.

SCALLION, a species of onion that never forms any bulb at the root. It is generally used green in the spring, before the real onions are ripe.

SCALPING, a barbarous custom among Indian warriors, of taking off the enemies' scalps with the hair on. These are preserved as trophies of prowess and victory; and those who produce the greatest number, receives from the chiefthe highest honours, and most ample rewards.

SCALY Diseases, are such as affect the skin, the cuticle dividing into small detached white laminæ. The elephantiasis, or leprosy, is of this description.

SCAMMONY, in the Materia Medica, a concreted vegetable juice of a plant of the same name.

SCANDALUM Magnatum, is the special name of astatute, and also of a wrong done to any high personage of the land, as prelates, dukes, marquisses, earls, barons, and other nobles; and also the chancellor, treasurer, clerk of the privy seal, steward of the house, justice of one bench or other, and other great officers of the realm, by false news, or horrible or false messages, whereby debates and discord between them and the commons, or any scandal to their persons, might arise. 2 Richard II. c. 5. This statute has given name to a writ granted to recover damages thereupon. It is now clearly agreed, that though there be no express words in the statute which give an action, yet the party injured may maintain one on this principle of law, that when a statute prohibits the doing of a thing, which if done might be prejudicial to another, in this case he may have an action on that very statute for his damages.

**SCANDENS**, in Botany, is a climbing stem, whether supported by tendrils like the vine, adhesive fibres like ivy, or its own circumvolutions, like the convolvulus and honeysuckle.

**SCANNING**, in Poetry, the measuring of a verse by feet, in order to see whether or no the quantities be duly observed. The term is chiefly used in regard to the Greek and Latin verses. Thus an hexameter verse is scanned, by resolving it into six feet; a pentameter, by resolving it into five feet, &c.

**SCANT**, is a term applied to the wind when it becomes unfavourable to a ship's course, after having been fair. It is distinguished from a foul wind, as in the former a ship is still enabled to sail on her course, although her progress is considerably retarded, but in the latter she is obliged to deviate from it.

**SCANTLING**, the dimensions of any piece of timber with regard to its breadth and thickness.

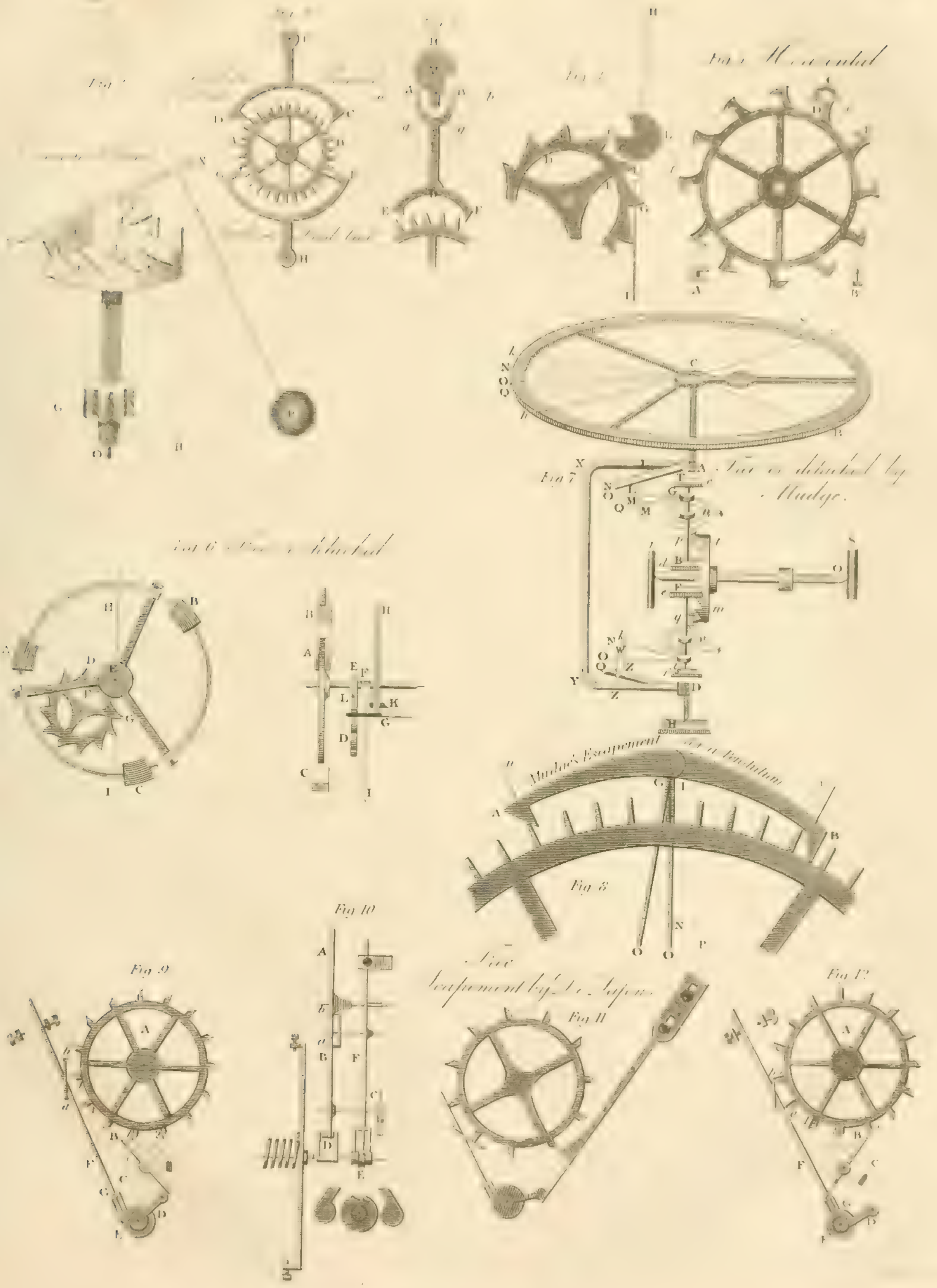
**SCANTLING**, a measure, size, or standard, by which the dimensions of things are determined. The term is now chiefly applied to timbers, &c. in buildings.

**SCAPE GOAT**, in Jewish antiquities, the goat which was set at liberty on the day of solemn expiation, typically to bear away the sins of the people.

**SCAPEMENT**, among Watchmakers, denotes the general contrivance by which the pressure of the wheels which move always in one direction, and the reciprocating motion of the pendulum or balance, are accommodated to one another; when a tooth of a wheel has given the balance or pendulum a motion in one direction, it must quit it, that it may get an impulsion in the opposite direction; and it is this escaping of the tooth of the wheel from the balance or pendulum, or of the latter from the former, whichever we choose to call it, that has given rise to the general term. From the nature of a pendulum, it follows, that it need only to be removed from the vertical, and then let go, in order to vibrate and measure time. Hence it might seem that nothing is wanted but a machinery so connected with the pendulum as to keep a register, as it were, of the vibration. It could not be difficult to contrive a method of doing this, but more is wanted; the air must be displaced by the pendulum. This requires some force, and must therefore employ some part of the momentum of the pendulum. The pivot on which it swings occasions friction; the thread, or thin piece of metal by which it is hung, in order to avoid this friction, occasions some expenditure of force by its want of perfect flexibility or elasticity. These, and other causes, make the vibrations become more and more narrow by degrees, till at last the pendulum is brought to rest. We must, of course, have a contrivance in the wheelwork which will restore to the pendulum the small portion of force which it loses in every vibration. The action of the wheels, therefore, may be called a maintaining power, because it keeps up the vibrations. But this may affect the regularity of vibration. If it be supposed that the action of gravity renders all the vibrations isochronous, we must grant that the additional impulsion by the wheels will destroy that isochronism, unless it be so applied that the sum total of this impulsion and the force of gravity may vary so with the situation of the pendulum as still to give a series of forces, or a law of variation, perfectly similar to that of gravity. This cannot be effected, unless we know both the law which regulates the action of gravity, producing isochronism of vibration, and the intensity of the force to be derived from the wheels in every situation of the pendulum. Thus it appears that considerable scientific skill, as well as mechanical ingenuity, may be displayed in the construction of scapements; and the judicious consideration of them becomes of great importance to the artist: yet, notwithstanding this, no material improvement was made in them from the first application of the pendulum to clocks till the days of Mr. George Graham; nothing more was attempted before his time than to apply the impulse of the swing-wheel in such manner as was attended with the least friction, and would give the greatest motion to the pendulum. Dr. Halley discovered, by some experiments made at the Royal Observatory at Greenwich, that by adding more weight to the pendulum it was made to vibrate larger arcs, and the clock went faster; by diminishing the weight of the pendulum, the vibrations became shorter, and the clock went slower; the result of these experiments being diametrically opposite to what ought to be expected from the theory of the pendulum, probably first roused the attention of Mr. Graham, who was not only skilful in practice, but had much mathematical knowledge, and was well qualified to examine the subject scientifically: he soon made such further trials as convinced him, that this seeming paradox was occasioned by the retrograde motion, which was given to the swing-wheel by every construction of scapement that was at that time in use; and his great sagacity soon produced a remedy for this defect, by constructing a scapement which prevented all recoil of the wheels, and restored to the clock pendulum, wholly in theory, and nearly in practice, all its natural properties in its detached simple state. This scapement, with a few others of the most approved construction, will now be briefly described.

1. The scapement which has been in use for clocks and watches ever since their first appearance in Europe is extremely simple; and its mode of operation is too obvious to need much explanation. In fig. 1, (see *Plate*,) X Y represents a horizontal axis, to which the pendulum P is attached by a slender rod, or otherwise. This axis has two leaves C and D attached, one near each end, and not in the same plane, but so that when the pendulum hangs perpendicularly, and at rest, the piece C inclines a few degrees to the right hand, and D as much to the left. They commonly make an angle of from 70 to 90 degrees: they are called by the name of pallets. A F B represents a wheel turning round on a perpendicular axis E O, in the order of the letters A F E B. The teeth of this wheel are cut into the form of the teeth of a saw, leaning forward, in the direction of the motion of the rim. As they somewhat resemble the points of an old-fashioned royal diadem, this wheel has got the name of the crown-wheel. In watches it is often called the balance-wheel. The number of the teeth is generally odd, so that when one of them B is pressing on a pallet D, the opposite pallet C is in the space between two teeth A and I. The figure represents the pendulum at the extremity of its excursion to the right hand, the tooth A having just escaped from the pallet C, and the tooth B having just dropped on the pallet D. It is plain, that as the pendulum now moves over to the left, in the arch P G, the tooth B continues to press on the pallet D, and thus accelerates the pendulum, both during its descent along the arch P H, and its ascent along the arch H G. It is no less evident, that when the pallet D, by turning round the axis X Y, raises its point above the plane of the wheel, the tooth B escapes from it, and I drops on the pallet C, which is now nearly perpendicular. I presses C to the right, and accelerates the motion of the pendulum along the arch G P. Nothing can be more obvious than this action of the wheel in maintaining the vibrations of the pendulum. We can easily perceive also, that when the pendulum is hanging perpendicularly in the line X H, the tooth B, by pressing on the pallet D, will force the pendulum a little way to the left of the perpendicular, and will force it so much the further as the pendulum is lighter; and, if it be sufficiently light, it will be forced so far from the perpendicular, that the tooth B will escape, and then I will catch on C, and force the pendulum back to P, where the whole operation will be repeated. The same effect will be produced in a more remarkable degree, if the rod of the pendulum be continued through the axis X Y, and a ball Q put on the other end to balance P. And, indeed, this is the contrivance which was first applied to clocks all over Europe, before the application of the pendulum. They were balance clocks. The force of the wheel was of a certain magnitude, and therefore able, during its action on a pallet, to communicate a certain quantity of motion and velocity to the balls of the balance. When the tooth B escapes from the pallet D, the balls are then moving with a certain velocity and momentum. In this condition, the balance is checked by the tooth I catching on the pallet C. But it is not instantly stopped. It continues its motion a little to the left, and the pallet C forces the tooth I a little backward. But it cannot force it so far as to escape over the top of the tooth I; because all the momentum of the balance was generated by the force of the tooth B; and the tooth I is equally powerful. Besides, when I catches on C, and C continues its motion to the left, its lower point applies to the face of the tooth I, which now acts on the balance by a long and powerful lever, and soon stops its further motion in that direction; and now, continuing to press on C, it

# *Escapements.*



urges the balance in the opposite direction. Thus we see that in a scapement of this kind the motion of the wheel must be very hobbling and unequal, making a great step forward, and a short step backward, at every beat. This has occasioned the contrivance to get the name of the recoiling scapement, or the scapement of recoil. In this scapement the vibrations are quicker than if the balance or pendulum vibrated freely: for the recoil shortens the ascending part of the vibration, by contracting the extent of the arc, and the re-action of the wheel accelerates the descending part of the vibration. In this scapement, too, if the maintaining power be increased, the vibration will be performed in larger arcs, but in less time: because the greater pressure of the crown-wheel on the pallet will cause the balance to vibrate through larger arches; and the time will be less increased on this account than it will be diminished by the acceleration that pressure gives to the balance and the diminution of the time of recoil.

2. The preceding scapement not being well adapted to such vibrations as are performed through arcs of a few degrees only, another construction has been made, which has been in constant use for about a century in clocks, with a long pendulum beating seconds. In fig. 2, A B represents a vertical wheel called the swing-wheel, having thirty teeth. C D represents a pair of pallets connected together, and moveable in conjunction with the pendulum on the centre or axis F. One tooth of the wheel, as shewn in the figure, rests on the inclined surface of the inner part of the pallet C; on which its disposition to slide tends to throw the point of the pallet further from the centre of the wheel, and consequently assists the vibration in that direction. While the pallet C moves outwards and the wheel advances, the point of the pallet D of course approaches towards the centre in the opening between the two nearest teeth; and when the acting tooth of the wheel slips off, or escapes from the pallet C, another tooth on the opposite side immediately falls on the exterior inclined face of D, and by a similar operation tends to push that pallet from the centre. The returning vibration is thus assisted by the wheel, while the pallet C moves towards the centre, and receives the succeeding tooth of the wheel, after the escape from the point of D. Thus may the alternation be conceived to go on without limit. In this scapement, as well as the former, the vibrating part is constantly under the influence of the maintaining power, except during the interval of the drop, or actual escape of the wheel from one pallet to the other. One principal recommendation of this scapement seems to have been the facility with which it affords an index for seconds in the face of the clock. Though the pendulum, according to this construction, is constantly connected with the maintaining power in a clock, yet the variations of that power have not the same mischievous effect as in a watch, because the momentum of the pendulum, compared with the impulse of the maintaining power, is prodigiously greater in the former of these instruments. A very considerable change in the maintaining power of a clock with a long pendulum will only cause a variation of a few seconds in the daily rate.

3. Mr. Graham's scapement, already spoken of, was a conderable improvement upon that just described. He took off part of the slope furthest from the points of the pallets; and instead of that part he formed a circular or cylindrical face, having its axis in the centre of motion. Pallets of this kind are shewn at the lower part of fig. 2, at E and G, having H for their centre or axis. A tooth of the wheel is seen resting upon the circular inner surface of the pallet G, which therefore is not affected by the wheel, excepting so far as its motion, arising from any other cause, may be affected by the friction of the tooth; and this resistance is exceedingly minute, not amounting to one-eighth of the pressure on the arch. Nay, we think it appears from the experiments of Coulomb, that, in the case of such minute pressure on a surface covered with oil, there is no sensible retardation analogous to that produced by friction, and that what retardation we observe arises entirely from the clamminess of the oil. If the vibration of the pendulum be supposed to carry G outwards, the slope surface will be brought to the point of the tooth, which will slide along it, and urge the pallet outwards during this sliding action. When the tooth has fallen from the point of this pallet, an opposite tooth will be received on the circular surface of E, and will not affect the variation, excepting when the slope surface of E is carried out so as to suffer the tooth to slide along it. This contrivance is known by the name of the dead beat, or the dead scapement; because the seconds index stands still after each drop, whereas the index of a clock with a recoiling scapement is always in motion, hobbling backward and forward.

In this scapement, an increase of the maintaining power renders the vibrations larger and slower: because the greater pressure of the tooth on the edge of the pallet throws it round through a greater arch: and its increased pressure on both surfaces of the pallet retards its motion.

4. The effect of the escapement which has been called horizontal, because the last wheel in watches of this construction has its plane parallel to the rest of the system, is similar to that of the dead beat scapement of Graham. In fig. 5, the horizontal wheel is seen with twelve teeth, upon each of which is fixed a small wedge supported above the plane of the wheel, as may be seen at the letters A and B. On the verge of the balance there is fixed part of a hollow cylinder of steel or other hard material, the imaginary axis of which passes through the pivots of the verge. C represents this cylindrical piece, into which the verge D may be supposed to have fallen. While the vibration causes the cylindrical piece to revolve in the direction which carries its anterior edge towards the axis of the wheel, the point of the wedge will merely rub the internal surface, and no otherwise affect the vibration of the balance than by retarding its motion. But when the return of the vibration clears the cylinder of the point of the wedge D, the wheel will advance, and the slope surface of the wedge acting against the edge of the cylinder will assist the vibration of the balance. When the edge of the cylinder arrives at the outer point of the wedge D, its posterior edge must arrive at the position denoted by the dotted lines of continuation; immediately after which the wedge or tooth E will arrive at the position *e*, and rest on the outer surface of the cylinder, where it will produce no other effect than that of retardation from friction, as was remarked with regard to the wedge D, until the course of the vibration shall bring the posterior edge of the cylinder clear of the point of the wedge. In this last situation, the wedge will act on the edge of the cylinder, and assist the vibration, as in the former case, until that edge shall arrive at the outer or posterior point of the wedge, immediately after which the leading point will fall on the inner surface of the cylinder in the first position, as was shewn in the wedge D.

Horizontal watches were greatly esteemed during the last thirty years, until lately, when they gave place to those constructions which are known by the name of detached or free scapements. In the common scapement, fig. 1, an increase of the maintaining power increases the recoil, and accelerates the vibration; but with the horizontal scapement there is no recoil; and an increase of the maintaining power, though it may enlarge the arc of vibration, will not necessarily diminish or alter the time. It is accordingly found, that the experiment of altering the maintaining power by the application of the key does not alter the rate in the same perceptible manner as in common watches.

5. Fig. 6, represents the free scapement of our best portable time-pieces. Fig. 4, exhibits the scapement on a large scale. On the verge of the balance is fixed a circular piece of sapphire, or of hard steel, E L, out of which a sectoral piece is cut. H G is a straight spring fixed near its extremity H, and having at the other extremity a pin G, against which one of the teeth of the wheel D rests when the train is at rest. This spring has a slight tendency towards the centre of the wheel, but is prevented by the stop K from throwing the pin further inwards than just to receive the point of the tooth. I is a very slender spring fixed at the end I, and pressing very slightly against the pin G, in a direction tending to throw it from the wheel D, but which on account of the greater power of H G it cannot effect. It may be observed that the spring I proceeds a little beyond the pin G.—F is a lever proceeding from the verge of the balance directly opposite the end of the spring I, and long enough to strike it in its vibration. The action is as follows:—From the pressure of the main spring, the wheel (fig. 4,) is urged from D towards F, but is prevented from moving by the pin G. Let the balance be made to vibrate, and the lever F will move through

the arc F$f$, strike the inner extremity of the spring, I, and displace the pin G. At this instant the face E, which may be called the pallet, will have arrived at the position $e$, against which the tooth of the wheel will fall, and communicate its impulse through about 15° or 16° of the vibration. But F quits the spring I sooner than the wheel quits the pallet E, and consequently the pin G will have returned to its first station before the wheel can have advanced a whole tooth, and the spring or detent H G will receive the wheel as before, immediately after its escape from the pallet. The returning vibration of the balance will be made with the piece E L perfectly at liberty between two teeth of the wheel, as in the sketch, and the back stroke of the lever F against the tender spring I will have no effect whatever on the pin G; this spring being like the back spring of the jacks of the harpsichord, active in one direction only. The third vibration of the balance will unlock the detent as before: the impulse will again be given, and the whole process will be repeated; and in this manner, the balance, though it may vibrate through the greatest part of the entire circle, will be entirely free of the works, except during the very small time of the drop of the wheel.

It is hardly necessary to make any remark on this scapement. It requires little or no oil, and when all the parts, particularly the pendulum spring, are duly adjusted, it is found that a very great variation in the first mover will remarkably alter the arc of vibration without affecting the rate. The piece E L might have consisted of a single pallet or arm, instead of a portion of a circle or cylinder; but such a piece would have been rather less convenient to make in sapphire, or ruby, as in the best time-pieces, and would also have been less useful. For if by any accident or shock, the pin G should be displaced for an instant, the wheel D will not run down, because it will be caught upon the circular surface E L. It is, indeed, very easy to observe, that the piece E L would operate without the detent, though with much friction during the time of repose. The tooth of the wheel would in that case rest upon its circular face.

6. In the two last scapements we have seen the variable effects of the maintaining power almost entirely removed, as far as can be practically discerned. Fig. 7, exhibits the scapement of Mudge; in which the balance is perfectly detached from the train of wheels, except during the extremely short interval of striking out the parts which serve the purpose of detents. O N E B Q is the circumference of the balance, vibrating by the action of a spiral spring as usual on its axis C A D H passing through the centre C: the axis is bent into a crank, A X Y D, to make room for the other work. L M, Z W, are two rods fixed to the crank at the points L and Z, parallel to X Y $c\,d\,e\,f\,r\,s$ are fixed parts of the machine. T R is an axis concentric with that of the balance, and carrying an arm G $o$ nearly at right angles to it, and a small auxiliary spring $u$, which is wound up whenever the arm G $o$ is moved in the direction $o\,h$. $p$ is a curved pallet fixed to the axis T R, which receives the tooth of the balance wheel near the axis. The tooth, proceeding along the curved surface, by the force of the main spring turns the axis and its arm G $o$, and winds up the spring $u$. A small projection at the extremity of the curved surface of the pallet $p$ prevents the further progress of the tooth, when the arm $o$ G has been turned through an arc $o\,h$, of about 27 ; and consequently the spring $u$ has been wound up through the same angle or arc, $o\,G\,h = 27^\circ$.——F S is another axis exactly similar to T R. It carries its arm I $o$, and spring $v$, and the tooth of the balance-wheel $l\,m$ winds up the spring $v$, by acting on the pallet $q$, and is detained by a projection, after having carried it through an angle of 27°, exactly as in the former case. The arcs passed through by the arms G $o$ and I $o$, and marked in the figure, are also denoted by the same letters on the rim of the balance.

The effect of this scapement may be thus explained: let the balance be in the quiescent state, the main spring being unwound, and the branch or crank in the position represented in the figure. If the quiescent points of the auxiliary springs coincide with that of the balance-spring, the arm G $o$ will just touch the rod L M, and in the like manner the arm I O will just touch the rod W Z; the two arms G $o$ and I $o$ in this position are parallel to the line C O. This position of the balance and auxiliary springs remains as long as the main spring of the machine continues unwound: but whenever the action of the main spring sets the balance wheel in motion, a tooth thereof meeting with one or other of the pallets $p$ or $q$, will wind up one of the auxiliary springs; suppose it should be the spring $u$. The arm G $o$ being carried into the position G $h$, by the force of the balance wheel acting on the pallet $p$, remains in that position as long as the tooth of the balance-wheel continues locked by the projection at the extremity of the pallet $p$; and the balance itself not being at all affected by the motion of the arm G $o$, nor by the winding up of the spring $u$, remains in its quiescent position; consequently no vibration can take place except by the assistance of some external force to set the balance in motion. Suppose an impulse to be given sufficient to carry it through the semi-arc O B, which is about 135° in Mr. Mudge's construction.

The balance, during this motion, carries with it the crank A X Y D, and the affixed rods L M, Z W. When the balance has described an angle of about $27^\circ =$ the angle $o\,C\,h$, or $o\,G\,h$, rod L M meets with the arm G H, and by turning the axis T R, and the pallet $p$ in the direction of the arc O $h$, releases the tooth of the balance wheel from the projection at the extremity of the pallet $p$: the balance wheel immediately revolves, and the lower tooth meeting with the pallet $q$, winds up the auxiliary spring $v$, and carries the arm I $o$ with a circular motion through the angle $o\,I\,h$, about 27°, in which position the arm I $o$ remains as long as the tooth of the balance-wheel is locked by the pallet $q$. While the spring $v$ is winding up through the arc $o\,h$, the balance describes the remaining part of the semi-arc $h$ B, and during this motion the rod L M carries round the arm G $h$, causing it to describe an angle $h$ C B, or $h$ G B, which is measured by the arc $h\,B = 108^\circ$. When the balance has arrived at the extremity of the semi-arc $O\,B = 135^\circ$, the auxiliary spring $u$ will have been wound up through the same angle of 130°, that is to say, 27°, by the force of the main spring acting on the pallet $p$, and 108° by the balance itself, carrying along with it the arm G $o$ or G $h$, while it describes the arc $h$ B. The balance therefore returns through the arc B O, by the joint action of the balance-spring and the auxiliary spring $u$; the acceleration of both springs ceasing the instant the balance arrives at the quiescent point $o$. When the balance has proceeded in its vibration about 27° beyond the point O, to the position C $k$, the rod Z W meets with the arm I $k$, and by carrying it forward releases the tooth of the balance-wheel from the pallet $q$. The balance-wheel accordingly revolves, and the upper tooth meeting with the pallet $p$ winds up the auxiliary spring $u$ as before. The balance with the crank proceeding to describe the remaining semi-arc $k$ E, winds up the spring $v$ through the further angle $k\,C\,E = 108^\circ$, and returns through the semi-arc E $o$, by the joint action of the balance-spring and the auxiliary spring $v$, both of which cease to accelerate the balance the instant it has arrived at O.

It may be remarked, in this curious scapement, that the motion of the balance in its semi-vibration from the point of quiescence is opposed through an arc of no more than 108°, but is accelerated in its return through the whole arc of 135°, and that the difference is what maintains the vibrations; and moreover, that the force from the wheel being exerted to wind up each auxiliary spring during the time it is totally disengaged from the balance, this last organ cannot be effected by its irregularities, except so far as they may render it more difficult to disengage the rim of the pallet from the tooth. The balance describes an arc of about 8° during this disengagement.

Count Bruhl, in his pamphlet "On the Investigation of Astronomical Circles," after describing Mudge's scapement, proceeds thus: "By what has been said, it is evident, that whatever inequality there may be in the power derived from the main-spring (provided the latter be sufficient to wind up those little pallet-springs), it can never interfere with the regularity of the balance's motion, but at the instant of unlocking the pallets which is so instantaneous an operation, and the resistance so exceedingly small, that it cannot possibly amount to any sensible error. The removal of this great obstacle was certainly never so effectually done by any other contrivance, and deserves the highest commendation as a probable means to perfect a portable machine that will measure time correctly. But this is not the only, nor indeed the principal advantage which this time-keeper will possess over any other; for as it is impossible to reduce friction to so small a quantity as not to affect the motion of a balance, the consequence of which is, that it describes sometimes greater and sometimes smaller arcs, it became necessary to think of some method by which the balance might be brought to describe those different arcs in the same time. If a balance could be made to vibrate without friction or resistance from the medium in which it moves, the mere expanding and contracting of the pendulum-spring would probably produce the so much wished for effect, as its force is supposed to be proportional to the arcs described; but as there is no machine void of friction, and as from that cause, the velocity of every balance decreases more rapidly than the spaces gone through decrease, this inequality could only be removed by a force acting on the balance, which assuming different ratios in its different stages, could counterbalance that inequality. This very material and important remedy, Mr. Mudge has effected by the construction of his scapement; for his pallet springs having a force capable of being increased almost at pleasure, at the commencement of every vibration, the proportion in their different degrees of tension may be altered till it answers the intended purpose. This shews how effectually Mr. Mudge's scapement removes the two greatest difficulties that have hitherto baffled the attempts of every other artist, namely, the inequalities of the power derived from the main spring, the irregularities arising from friction, and the variable resistance of the medium in which the balance moves."

7. Fig. 8, is the sketch of an adaptation of Mudge's scapement to a clock. L M is a part of the periphery of the wheel. G A, G B, are two arms separately moveable on the same axis, and terminating in the pallets A, B. These pallets have inclined faces, with a claw or detent at the lower part of each. G O, I O, are tails proceeding from each pallet piece respectively, and the dark spot at N represents a pin proceeding from the pendulum rod, and capable of moving either of the tails according to the course of the vibration. The dotted circles *u* and *v* represent weights which are stuck upon two pins, and may be changed for others, greater or smaller, until the most suitable quantity is found. Suppose the wheel to be urged from L towards M, and the pendulum made to vibrate by external impulse; the pin N proceeding towards L will strike the tail G O, raise the pallet A, and set the wheel at liberty: which sliding along the inner surface of tbe pallet B, will raise it, and stop against the claw at its lower end. I O will consequently be carried into the position I P; and the pallet A in its return will be opposite to a vacancy, which will permit the tail G O to follow the pin N as far as the perpendicular situation. The pendulum will therefore be assisted by the weight *u* through a longer arc in its descent, than it was impeded by it in its ascent. In the opposite semi-vibration toward M, the pendulum will proceed unopposed by *v*, while it passes through the angle O I P, when it will raise B, and permit the wheel to elevate the pallet A. In the motion on this side of the perpendicular, it is also clear that the descent will be more assisted than the ascent was impeded. Whence it follows, that the clock will continue to go: and no variation of the force of the wheel L M, which raises the pallets in the absence of the pendulum will affect the vibration, except so far as it may afford a variable resistance at the detent or claw.

8. Mr. Mudge has also given another detached scapement, which he recommends for pocket watches, and executed entirely to his satisfaction in one made for the queen. A dead-beat pendulum scapement is interposed between the wheels and the balance. The crutch E D F (fig. 3. has a third arm D G standing outwards from the meeting of the other two, and of twice their length. This arm terminates in a fork A G B. The verge V has a pallet C, which, when all is at rest, would stand between the points A, B, of the fork. But the wheel by its action on the pallet E, forces the fork into the position B *g b*, the point A of the fork being now where B was before, just touching the cylindrical surface of the verge. The scapement of the crutch E D F is not accurately a dead-beat scapement, but has a very small recoil beyond the angle of impulsion. By this circumstance the branch A (now at B) is made to press most gently on the cylinder, and keeps the wheel locked, while the balance is going round in the direction B H A. The point A gets a motion from A to B by means of a notch in the cylinder, which turns round at the same time by the action of the branch A G on the pallet C; but A does not touch the cylinder during this motion, the notch leaving free room for its passage. When the balance returns from its excursion, the pallet C strikes on the branch A (still at B), and unlocks the wheel. It is now acting on the crutch-pallet F, causes the branch *b* of the fork to follow the pallet C, and give it a strong impulse in the direction in which it is then moving, causing the balance to make a semi-vibration in the direction A H B. The fork is now in the situation A *g a*, similar to B *g b*, and the wheel is again locked on the crutch pallet E.

The intelligent reader will admit this to be a very steady and effective scapement. The lockage of the wheel is procured in a very ingenious manner; and the friction on the cylinder, necessary for effecting this, may be made as small as we please, notwithstanding a very strong action of the wheel; for the pressure of the fork on the cylinder depends entirely on the degree of recoil that is formed on the pallets E and F. Pressure on the cylinder is not indispensably necessary, and the crutch-scapement may be a real dead-beat. But a small recoil, by keeping the fork in contact with the cylinder, gives the most perfect steadiness to the motion. The ingenious inventor, a man of approved integrity and judgment, declares that her majesty's watch was the best pocket-watch he had ever seen. We are not disposed to question its excellency.

9. Another scapement, in which a considerable degree of ingenuity is united with comparative simplicity, is that of Mr. De Lafons. The inventor's description and some of his observations, as presented to the Society of Arts, are as follows:—Although the giving an equal impulse to the balance has been already most ingeniously done by Mr. Mudge and Mr. Halley (from whose great merit we would not wish to detract,) yet the extreme difficulty and expense attending the first, and the very compound locking of the second, render them far from completing the desired object. The perfections and advantages arising from my improvements on the remontoire detached scapement for chronometers, which gives a perfectly equal impulse to the balance, and not only entirely removes whatever irregularities arise from the different states of fluidity in the oil, from the train of wheels, or from the main spring, but does it in a simpler way than any with which I am acquainted. I trust it will not be thought improper in me to answer some objections made at the examinations before the committee, as I am fully persuaded the more mathematically and critically the improvements are investigated, the more perfect they will prove to be. It was first observed that my method did not so completely detach the train of wheels from the balance as another scapement then referred to. I beg leave to remark, that the train of wheels in mine is prevented from pressing against the locking by the whole power of the remontoire-spring: so that the balance has only to remove the small remaining pressure, which does away that objection, and also that of the disadvantage of detents, as this locking may be compared to a light balance turning on fine pivots, without a pendulum spring; and has not only the advantage of banking safe at two turns of the balance, and of being firmer and less liable to be out of repair than any locking where spring work is used, but likewise of unlocking with much less power.—It was then observed, it required more power to make it go than usual. Permit me to say, it requires no more power than any other remontoire-scapement, as the power is applied in the most mechanical manner possible.—And, lastly, it was said, that it set or required the balance to vibrate an unusually large arch before the piece would go. This depends on the accuracy of the execution, the proportionate diameter and weight of the balance, the strength of the remontoire-spring, and the length of the pallets. If these circumstances are well attended to, it will set but little more than the most generally detached scapements. A, fig. 9, shews the scape wheel; B, the lever-pallet, on an arbor with fine pivots, having at the lower end, C, the remontoire or spiral-spring fixed with a collar and stud, as pendulum-springs are; D the pallet of the verge, having a roller turning in small pivots for the lever pallet to act against; E pallets to discharge the locking, with a roller between, as in fig. 10; F, the arm of the locking-pallet continued at the other end to make it poise, having studs and screws to adjust and bank the quantity of

motion; *a*, and *b*, the locking pallets, being portions of circles fastened on an arbor turning on fine pivots; G, the triple fork, at the end of the arm of the locking pallets. The centre of the lever pallet in the draft, is in a right line between the centre of the scape wheel and the centre of the verge, though in the model it is not; but may be made so or not, as best suits the calliper, &c.

The scape-wheel A, with the tooth I, is acting on the lever-pallet B, and has wound up the spring C; the verge pallet D (turning the way represented by the arrow) the moment it comes within the reach of the lever pallet, the discharging pallet E, taking hold of one prong of the fork, removes the arm F, and relieves the tooth *p* from the convex part of the lock *a*. The wheel goes forward a little, just sufficient to permit the lever-pallet to pass, while the other end gives the impulse to the balance; the tooth 4 of the wheel is then locked on the concave side of the lock *b*, and the lever-pallet is stopped against the tooth 5, as in fig. 11. So far the operation of giving the impulse, in order again to wind the remontoire spring (the other pallet at E, in the return removing the arm F the contrary direction), relieves the tooth 3 from the lock *b*. The wheel again goes forward, almost the whole space from tooth to tooth, winds the spiral spring again, and comes into the situation of fig. 1, and thus the whole performance is completed. The end of the lower pallet B resting on the point of the tooth 1, prevents the wheel exerting its full force on the lock *a*, as in fig. 1, The same effect is produced by the pallet lying on the tooth 5, by preventing the wheel from pressing on *b*; and thus the locking becomes the tightest possible. This scapement may be much simplified by putting a spring with a pallet made in it as in fig. 12, instead of the lever pallet, and spiral-spring. The operation will be in other respects exactly the same, avoiding the friction of the pivots of the lever-pallet. This method I prefer for a piece to be in a state of rest, as a clock; but the disadvantage from the weight of the spring in different positions, is obvious. The locking may be on any two teeth of the wheel, as may be found most convenient.—*Dr. Gregory's Mechanics.*

Many other ingenious scapements have been contrived by Harrison, Hindley, Ellicott, Lepaute, Le Roy, Berthoud, Arnold, Whitehurst, Earnshaw, Nicholson, &c. But descriptions of them would extend this article to much too great a length. What is here collected will, we trust, furnish some insight into the nature of a few of the most approved scapements.

SCAPHISM, an unseemly torture among the ancient Persians, by which criminals were exposed to be stung to death by wasps.

SCAPOLITE, a mineral found at Arendal in Norway. It is of a pearl colour, and is crystallized in long, four-sided rectangular prisms. Faces longitudinally streaked. Its specific gravity is 3·68, and it is hard enough to scratch glass.

SCARABÆUS, in Natural History, the *Beetle*, a genus of insects of the order coleoptera. In this genus there are several hundred species, in four divisions, which are distinguished by the form of their feelers. The beetle is the most remarkable species, as well in size as in beauty. It is five or six inches long; the wing-shells are of a smooth surface, of a bluish-gray colour, marked with round deep-black spots of different sizes. In this country, the cockchafer is very common. The larva inhabits ploughed lands, and feeds on the roots of corn; and the complete insect makes its appearance during the middle and the decline of summer. The larva of this insect is eagerly sought after and devoured by swine, bats, crows, and poultry; it is said to be two or three years in passing from its first form into that of the perfect insect. A species of great beauty is the golden beetle, about the size of the common or black garden beetle; the colour is most brilliant, varnished, and of a golden green. This is a fine object for the magnifying glass. It is not very uncommon during the hottest parts of summer, frequenting various plants and flowers; its larva is commonly found in the hollows of old trees, or among the loose dry soil at their roots, and sometimes in the earth of ant hills.

SCARFING, a sea term, a particular method of uniting two pieces of timber together by the extremities, so that the end of one goes over the end of the other, being tapered so that the one may be set into the other, and become even, as the keel-pieces. But when the ends of the two pieces are cut square and put together, they are said to butt to one another, (see the article Butt;) and when another piece is laid on and fastened to both, as is the case in all the frame timbers, this is called scarfing the timbers, and half the piece which fastens the two timbers together is reckoned the length of the scarf.

SCARIFICATION, in Surgery, the operation of making several incisions in the skin by means of lancets or other instruments, particularly the cupping-instrument.

SCARLET, a beautiful bright red.

SCARP, in Fortification, the interior slope of the ditch with which the fortification is surrounded, and faces the country or champaign.

SCAVAGE, a toll or custom anciently exacted by mayors, sheriffs, and bailiffs of cities and towns-corporate, and of merchant strangers, for wares exposed and offered to sale within their liberties, which was prohibited by 19 Hen. VII. But the city of London still retains this custom.

SCAVENGERS, two officers chosen annually in each parish in London and the suburbs, whose business it is to see that the streets are kept clean, under a penalty of forty shillings for each offence.

SCELOTYRBE, a disease characterized principally by a contraction of the limbs. For this, various causes have been assigned.

SCENE, in a primary sense, denotes a theatre, where dramatic pieces, and other public shows, were represented. Its application is now extended to picturesque views of almost every description.

SCENOGRAPHY, in Perspective, the perspective representation of a body on a plane; or a description and view of it in all its parts and dimensions, such as it appears to the eye in any oblique view.

SCENOPEGIA, a grand festival among the Jews, at which all their males of a given age were to attend at their national altar. It is more generally called "the feast of tabernacles."

SCENT, in Hunting, the effluvia thrown off by animals in the chase, and by which they are followed through all their mazes and retreats, by dogs and those who follow them. So acute is the sense of smelling in these hounds, that carcases buried with lime ten feet under ground, have been known to attract them to the spot. The term scent, in a lax sense, is sometimes applied to things highly offensive to the olfactory nerves, but frequently to aromatics, and agreeable odours.

SCEPTIC, one who embraces scepticism, and sometimes affects to doubt his own existence.

SCEPTICISM, doubt, hesitation, indecision, unbelief. Scepticism professes to weigh every thing, but it determines nothing. It robs the mind of its resting-place, but substitutes nothing in its stead.

SCHEDULE, a scroll of parchment or paper, annexed to a deed, will, or other instrument, containing an inventory of goods, &c. omitted in the body of the will or deed. It is used particularly for the statement of effects delivered by a bankrupt to the commissioners who are appointed to investigate his affairs. It also includes a list of such articles as are the subjects of taxation.

SCHEIK, a name given by the Turks to the prelates of the Mahometan religion, who pretend to be the legitimate successors of Mahomet. Their chief resides at Mecca.

SCHEME, representation of any geometrical or astronomical figure, or problem, by figures sensible to the eye; and also the harmonious result of contrivance and ingenuity.

SCHIECH, in Arabia, an officer of high birth, which can only come by descent, and is peculiar to princes, sovereigns, and independent lords. Among the Bedouins, this title belongs to every noble.

SCHIRROSIS, a name given to a disorder in the eyes, arising from a long continued inflammation, when the flesh increases in bulk, and assumes a livid colour.

SCHISM, literally, a cleft or fissure. In Religion, to which the term is chiefly applied, it means a separation among persons who profess the same general principles of faith, but differ in some subordinate particulars. The Romanists enumerate thirty-four schisms that have taken place in their church, among which, the ecclesiastical revolution that took place in the days of Luther, holds a prominent rank. The Reformation that took place in this country is called the English schism; and the English church, in its turn, applies the opprobrious epithet to Presbyterians, Independents, Anabaptists, and Methodists; while each of these sects cry out schism against all who secede from their respective communities.

SCHISTUS, in Mineralogy, a name given to several different kinds of stones, but more especially to some of the argillaceous kind.

SCHOLASTIC, something belonging to the schools, or taught in them. Connected with Philosophy, it is a name given to the dialectic of Aristotle. From the fifth until the twelfth century, scholastic philosophy was held in high esteem. The Reformation inflicted on it a deadly wound, so that at present it is little studied, and less regarded.

SCHOLASTICS, persons who study either scholastic philosophy or divinity.

SCHOLIUM, a note, annotation, or remark; occasionally made on some passage or proposition of an old author.

SCHOOL, a public place in which languages, arts, and sciences, are taught. Schools vary in character and degree, according to the subjects introduced, from the elementary principles of words, to the result of academic researches, and the learning inculcated in the most renowned universities. In the management of schools considerable improvements have been made of late years, but more generally in their lower departments. The word *Schola* originally signifies *discipline* and *correction*, and it was anciently used to designate all places where persons met together either to study, to converse, or to do any other matter. Among the Hebrews, the synagogues succeeded the schools of the prophets.

The *Charity* SCHOOLS in England are both numerous and opulent, but replete with abuses. Winchester, Eton, and Westminster schools, are royal foundations. All the other grammar schools, as they are termed, are, in fact, charity schools, though of a higher class than the parish schools for the education of our pauper youth.

*Sunday* SCHOOLS, another species of charity schools, have many advocates, as have also the National Schools; and were they universally adopted, we might expect to see the morality of the nation keep pace with these benevolent institutions. Juvenile offenders, without doubt, are numerous; but our gaols are under no obligations to Sunday Schools for their inmates.

SCHOONER, a small vessel with two masts, whose mainsail and foresail are both suspended by gaffs, like a sloop's mainsail.

SCHORL, a mineral which derives its name from Schorlaw, in Saxony, where by him it was first discovered.

SCIARRI, the matter which runs in burning torrents from the craters of volcanoes.

SCIATHERICUM, a horizontal dial, with a telescope adapted for observing the true time, both by day and by night, to regulate and adjust pendulum clocks, watches, and other time-keepers.

SCIATIC STAY, a strong rope fixed from the main to the foremast heads in merchant ships: when loading or unloading, it serves to sustain a tackle, which travelling upon it, may be shifted over the main or fore hatchways, as occasion requires.

SCIENCE, in Philosophy, a clear and certain knowledge of any thing, founded on demonstration, or self-evident principles.

SCIENCES, *General Enumeration of the.*—PRINCIPLES of all things—ELEMENTS which these *principles* originate—BEINGS which these *elements* form—ORGANS which these *beings* develop—WANTS which these *organs* experience—SIGNS which these *wants* excite—SOCIETIES which these *signs* produce—COUNTRIES which these *societies* inhabit—EARTH which these *countries* compose—PLANETARY SYSTEM to which this *earth* belongs. Here the accurate observer will, perhaps, allow the implicit dependence of each succeeding on each preceding head; and if we next shew, that, under these heads, every individual science as naturally arranges itself, he will perhaps also grant, that we have traced the basis of a natural system. We shall, accordingly, place these ten successive and dependent heads in the first column of the following table, and range after each, in the third column, the triple science which it involves.

| *General Heads.* | *Particular Subjects.* | *Names of the Sciences.* | *Including, amongst others, the following Branches.* |
|---|---|---|---|
| Principles | Matter, Space, Motion.* | METAPHYSICS. | |
| | Extension, Divisibility, &c. | PHYSICS.† | |
| | Number, Form, Magnitude.* | MATHEMATICS, | Arithmetic, Geometry, Algebra, &c. |
| Elements. | Atoms, | ATOMOLOGY | — the doctrines of Heat, Light, Sound. |
| | Molecules, | CHEMISTRY | — Electricity, Galvanism, Magnetism. |
| | Masses, | MECHANICS | — Statics, Hydrostatics, Pneumatics. |
| Beings. | Minerals, | MINERALOGY. | |
| | Vegetables, | BOTANY. | |
| | Animals, | ZOOLOGY. | |
| Organs. | Forms, | PHYSIOGNOMY. | |
| | Structures, | ANATOMY | |
| | Actions, | PHYSIOLOGY | |
| Wants. | Clothing, | COSTUME. | |
| | Food, | GARDENING, &c. | |
| | Shelter, | ARCHITECTURE. | |
| Signs. | Speech, | LANGUAGE,<br>POETRY,<br>MUSIC, | Grammar, Composition, Style. |
| | Gesture, | GESTURE.<br>SCULPTURE.<br>PAINTING. | |
| | Writing, | LETTERS.<br>SYMBOLS.<br>HIEROGLYPHICS. | |
| Societies. | Families, | MORALS | — Manners, and the Drama. |
| | Cities, | CIVICS | — Statics,‡ Legislation, Administration. |
| | Nations, | POLITICS | — the relations of Peace, Diplomacy, War. |
| Countries. | Land, | GEOGRAPHY | — Geology and Palæontography. |
| | Sea, | HYDROGRAPHY. | |
| | Air, | AEROLOGY | — Meteorology. |
| Earth. | Its Form, &c.<br>Its motion,<br>Its Effects, | COSMOGRAPHY. | |
| Planetary System. | Their Forms, &c.<br>Their Motions,<br>Their Influence, | ASTRONOMY. | |

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* The subjects of these three lines differ considerably; but under Metaphysics, Physics as here employed, and Mathematics: they are all considered abstractly, and it is in that sense that we apply to them the general term—Principles.

† Extension, Divisibility, &c. are only the first subjects commonly placed under this head. We use the term in a limited sense. It is commonly used in a vague manner.

‡ Including the doctrines of property and money, as well as of population.

SCIENTIFIC, something relating to the pure, sublime sciences, or that abounds in science or knowledge. A work is said to be scientifical, when it is founded on the pure reason of the thing, or conducted wholly on their principles.

SCIERIA, a festival kept in Arcadia in honour of Bacchus.

SCILLA, the *Squill*, in Botany, a genus of the monogynia order, in the hexandria class of plants, and in the natural method ranking under the 10th order, coronariæ.—22 species.

SCIMPODIUM, an ancient bed or couch, adapted for one person only. It was also used instead of the Lectica, to carry both men and women, not only through the city, but likewise in journeys into the country.

SCINCUS, a species of lizard, sometimes called the Crocodile, and formerly well known in the shops of the druggists as an ingredient in several compositions.

SCIOPTIC BALL, a sphere or globe of wood, with a circular hole or perforation, in which a lens is placed. It is so contrived, that, like the eye of an animal, it may be turned round every way, and is used for making experiments in darkened rooms.

SCIRE FACIAS, is a judicial writ, and properly lies after a year and a day after judgment given; whereby the sheriff is commanded to summon or give notice to the defendant, that he appear and shew cause why the plaintiff should not have execution. 1 Inst. 290.

SCIRRHUS, in Surgery, a term that denotes any kind of swelling, accompanied with considerable hardness.

SCIRRONES, a species of small lice bred under the skin.

SCIRROPHORION, the last month of the Athenian year. It contained twenty-nine days, and corresponded with the latter part of our May and beginning of June.

SCITAMINEA, in Botany, an important order of plants, the eighth among the Fragmenta of Linnæus.

SCIURUS, the *Squirrel*, in Natural History, a genus of mammalia, of the order glires. These animals live principally on seeds and fruits. They are extremely active and nimble, climbing trees with great rapidity, and bounding from one to another with a spring truly astonishing. Some are supplied with membranes, which enable them to extend this leap into something approximating to a short flight. Some are subterraneous, and others build in trees. They are sprightly, elegant, and interesting. The sailing squirrel is an inhabitant of Java and the Indian islands, and can spring to an immense distance from tree to tree, by means of a membrane similar to that of the preceding, which is extremely thin in the middle, and thicker towards the extremities. This is the largest of all the flying squirrels, and is eighteen inches long, exclusively of the tail.

SCLEROTICA, in Anatomy, one of the tunics, or coats of the eye.

SCNIPS, a small species of gnat found about the oak, and sustained by the juices of its leaves.

SCOBS, the raspings of ivory, hartshorn, or other hard substances.

SCOLD, COMMON, a turbulent woman, liable to be indicted, and punished as a public nuisance. In the Saxon laws this punishment was the cucking-stool, now corrupted into the ducking stool.

SCOLEX, a genus of the Vermes intestina class and order.

SCOLIA, a genus of insects of the order hymenoptera.

SCOLIA, songs of the ancient Greeks.

SCOLOPAX, the *Curlew*, in Natural History, a genus of birds of the order grallæ. There are fifty species, of which the following are the chief: The common curlew, generally about two feet long, is to be met with in England throughout the year, either on the coasts or near the mountains. Slugs and worms, which its bill extracts from the ground in the morning and evening, constitute its inland subsistence; and when on the shores of the sea, it feeds on marine animals. These birds are often observed in large flocks, and are used by many for food. Those killed on the coasts, however, are rank and fishy.—The woodcock is about fourteen inches in length, migratory in this country, and supposed to proceed from Sweden.—The snipe, weighs about four ounces, is about twelve inches long, and to be found in nearly every country of the world. Its food consists of worms and insects, which it seeks near small streamlets and in general in wet grounds.—The common godwit, is of the weight of twelve ounces, and ranks in the highest order of delicacies.—The redshank, is not uncommon in this island, and particularly towards the south.

SCOLOPENDRA, in Natural History, centipede, a genus of insects of the order aptera. There are thirteen species found in almost all parts of the world; they live in decayed wood, or under stones, and some of them in fresh and salt water; they prey on other insects. The larger species are found only in the hotter regions of the gobe; they are insects of a terrific appearance, and possess the power of inflicting severe pain and inflammation by their bite.

SCOMBER, the *Mackarel*, in Natural History, a genus of fishes of the order thoracici. There are twenty-one species, of which we shall notice the following:—The common mackarel. This is one of the most beautiful of fishes, and inhabits both the European and American seas. The mackarel is a fish highly admired both for its beauty and excellence, and has in every age attracted particular notice and partiality from both these circumstances. The Romans prepared from it a condiment of essence for the table, which was in the highest estimation. The general length of this fish is fifteen inches, but specimens far larger have been occasionally met with.—The tunny is sometimes ten feet long, and on the Scotch coast one was taken which weighed four hundred and sixty pounds. In the Indian ocean, it is said to exceed even this enormous size. These fishes are not particularly admired for food in this country, in which, indeed they are rarely seen approaching the British coast only in straggling parties, or rather as solitary individuals. By the ancients, fisheries were established for taking and preserving them, on the coasts of the Mediterranean, in which sea they particularly abound, and there are at present on the same coasts very extensive establishments for this purpose. Indeed, to the inhabitants on those shores, the movements of tunny are watched and expected with as much eagerness as those of the herring or mackarel in the north. The small fishes are generally carried fresh to market, and the large ones are cut up into pieces of a particular size, and preserved in salt in barrels. The tunny is a very voracious fish, and a great persecutor of the common mackarel.

SCOOP, a little hollowed piece of wood employed to throw the water out of a boat, which operation is usually called baling the boat.

SCORE, in Music, the original and entire draught, or its transcript, of any composition.

SCORIA, or DROSS, is that mass which is produced by melting metals and ores, and when cold is brittle, and not insoluble in water; being properly a kind of glass.

SCORING, the art of forming a score by collecting, and properly arranging under each other, the several detached parts of any composition.

SCORPIO, the *Scorpion*, ♏, is the eighth sign in the order of the zodiac, and the second of the southern signs. The sun enters it on the 23d of October, according to the fixed and intellectual zodiac of Hipparchus and the moderns; but if we follow this sign in the recession of Aries and his train, we shall find that the sun enters Scorpio about the 20th of November. The ancient poets of Greece tell us, that this is the Scorpion which Diana sent to wound Orion for usurping her office. Ovid tells us, that this serpent was produced by the earth, to punish Orion's vanity for having boasted that there was not on the terraqueous globe any animal which he could not conquer. Again, it is said that Autumn, which produces fruits in great abundance, brings with it a variety of diseases; and this season is very fitly represented by a Scorpion, which wounds with its tail as it recedes.

*Boundaries and Contents.*—Scorpio is bounded on the north by Serpentarius and Serpens; east by Sagittarius; south by Lupus, Norma, and Ara; and west by Libra: but the tail of Scorpius does not rise at London. In this sign there are forty-four stars, of which, one is of the first magnitude, one of the second, eleven of the third, eighth of the fourth, &c. *Antares*, called also Cor Scorpii, of the first magnitude, rises on the south-east point of the horizon at London. Its declination is 26° 1′ 10″ south; its right ascension 244° 35′ 36″; and it rises and culminates as in the following table: Meridian altitude 12° 27′ 50″.

| MONTH. | RISES. | CULM. | MONTH. | RISES. | CULM. |
|---|---|---|---|---|---|
| | ho. mi. | ho. mi. | | ho. mi. | ho. mi. |
| Jan. | 6 0 M. | 9 28 M. | July | 6 15 A. | 9 37 A. |
| Feb. | 3 45 M. | 7 16 M. | Aug. | 4 15 A. | 7 33 A. |
| Mar. | 2 0 M. | 5 28 M. | Sept. | 2 15 A. | 5 37 A. |
| April | 12 10 M. | 3 34 M. | Oct. | 12 25 A. | 3 49 A. |
| May | 10 25 A. | 1 43 M. | Nov. | 10 25 M. | 1 53 A. |
| June | 8 25 A. | 11 41 A. | Dec. | 8 15 M. | 11 46 M. |

SCORPIO, in Natural History, a genus of insects of the order Aptera. There are ten species, all of which are armed with a slightly pungent sting; and in hot climates some of them are highly dangerous: they prey upon worms, spiders, flies, &c. and even on one another.

SCORPION, in the ancient art of war, an engine chiefly used in the defence of the walls of fortified places by throwing arrows, fireballs, or great stones.

SCOT, a customary contribution laid upon all subjects according to their abilities. Whoever were assessed to any contribution, though not by equal portions, were said to pay scot and lot.

SCOTCH FIR, common fir, or pine tree.

SCOTCHES, in Agriculture, a term signifying scores or notches. It is sometimes employed as a mode of reckoning, by farmers.

SCOTES, a species of duck, sometimes called the black diver.

SCOTIA, in Architecture, a semi-circular cavity or channel, between the tores in the bases of columns.

SCOTISTS, a sect of school divines and philosophers, so called from J. Duns Scotus, their founder, who flourished in the fourteenth century, but they are now unknown.

SCOTLAND. By 5 Anne, c. 8, the Union of England and Scotland was effected, and the twenty-five articles of union, agreed to by the parliaments of both nations, were ratified and confirmed as follows: *viz.* the succession to the monarchy of Great Britain shall be the same as before settled with regard to that of England. The united kingdoms shall be represented by one parliament. There shall be a communication of all rights and privileges between the subjects of both kingdoms, except where it is otherwise agreed. When England raises £2,000,000 by land-tax, Scotland shall raise £48,000. The standards of the coin, of weights and measures, shall be reduced to those of England throughout the united kingdoms. The laws relating to trade, customs, and excise, shall be the same in Scotland as in England. But all the other laws of Scotland shall remain in force, though alterable by the parliament of Great Britain; and particularly, laws relating to public policy are alterable at the discretion of parliament. Laws relating to private right are not to be altered, but for the evident utility of the people of Scotland. Sixteen peers are to be chosen to represent the peerage of Scotland in parliament, and forty-five members to sit in the house of commons. The sixteen peers of Scotland shall have all privileges of parliament, and all peers of Scotland shall be peers of Great Britain, ranking next after those of the same degree at the time of the union, and shall have all privileges of peers, except sitting in the house of lords, and voting on the trial of a peer.—It was formerly resolved by the house of lords, that a peer of Scotland, claiming and having a right to sit in the British house of peers, had no right to vote in the election of the sixteen Scotch peers; and that if any of the sixteen Scotch peers are created peers of Great Britain, they thereby cease to sit as representatives of the Scotch peerage, and new Scotch peers must be elected in their room.

SCOUR, in Military language, is to flank a line in such a manner as to go directly along it, so that a musket ball, entering at one end, may reach to the other, leaving no place of security.

SCOURING, among cattle, is a disease of the flux kind, which frequently proves mortal. Sheep are not exempt from its influence. Scouring, among Farriers, is a gentle purge, to preserve animals from noxious humours.

SCOUTS, in Military language, are generally horsemen sent out either before, or on the wings of an army, at the distance of a mile or two, to discover the enemy, and give some signal of alarm.

SCRAPER, an instrument used in mezzotinto engraving, formed much in the manner of a knife, except towards the point, where it slopes off at an angle from both sides. In common language, the application of the term to numerous utensils is well known.

SCRAPER, *Shipcarpenter's*, is an iron machine, having two or three sharp edges, used to scrape off the dirty surface of the planks on a ship's side, or decks, or to clean the topmasts, &c. When the sides of a ship are thus sufficiently scraped, they are varnished over with turpentine, or a mixture of tar and oil, &c. which prevents the planks from being rent or split by the sun or wind.

SCRATCH, the name of a calcareous, earthy, or stony substance, which separates it from sea water in boiling it for salt. This concretion, which forms itself on the sides and bottoms of the pans to which it adheres, is the same substance that crusts over the inside of our tea-kettles. It is a species of spar sustained more or less in all water, from which it is detached by boiling.

SCRATCHES, a disease in horses, consisting of dry chops, scabs, or rifts, that are generated between the heel and the pastern joint.

SCRATCH *Work*, a way of painting in fresco. It is rough, but lasting, and is chiefly used to embellish the fronts of magnificent buildings.

SCREEN, in domestic comfort, an instrument for keeping off the wind, or the excessive heat of the fire. In Building, *Screen* is used as a frame of laths, for sifting earth, lime, or sand. In Agriculture, *Screen*, among farmers, is a contrivance made chiefly of wires in a frame, for the purpose of separating grain of various kinds from seeds of weeds with which it was previously mixed.

SCREEN, is the name given to the pieces of canvass, or hammock, hung round a birth for warmth and privacy.

SCREW, one of the mechanical powers. *See* MECHANICAL *Power*

*Machine for Making an original and perfect Screw.*—This machine was invented by Mr. Angus Mackinnon, Glasgow. Fig. 1 is a plan, and fig. 2 is an end view of the machine for constructing the screw. A A is the cast-iron bar, upon which the die-frame B B is made to move; *c c c c*, two strong springs attached to the die-frame, having rollers, *d d d d*, in each end, moving upon the angular parallel edges of the bar A A. E, a small frame for holding the cutter; the cover being removed, to shew the action of the cutter upon the steel cylinder, of which the screw is to be made. F, the steel cylinder; the point of the cutter, (which must be adjusted to an angle, varying according to the pitch of thread wanted,) is seen projecting from the frame E, being pressed forward by the screw G. One end of the cylinder F acts upon the centre in the head-stock I. The journal upon the other end of the cylinder works into the steel collar V. *k k k k*, four small screws for pressing forward the springs *c c c c*. *l l l*, four small eyes in the die-frame, to which cords are attached, passing over the pulleys *m m m m*; weights

*Fig.* 1.

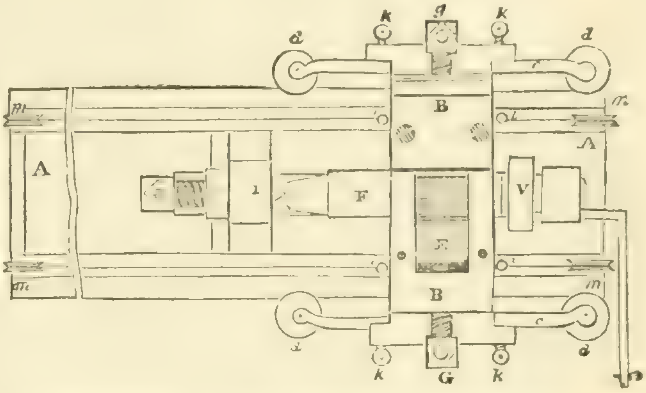
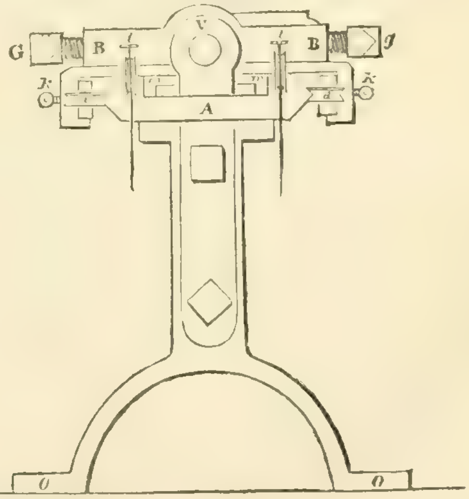


*Fig.* 2.



being hooked on at the other ends of the cords, sufficient to overcome the friction of the die-frame. N, the handle to turn the cylinder.

In beginning to make the screw, the two weights to the left are hooked on to the ends of the cords, and the cylinder is turned round by the handle, until the cutter traverses the length of the cylinder, when the weights are removed to the cords on the right hand. By continuing this operation alternately from right to left, an original and perfect screw is produced, as exhibited in fig. 3. In the end view of the machine, fig. 2, *o o* represents one of the feet by which it is fastened to a bench. The same letters refer to the same parts of the machine in both figures, where those parts are exhibited. Having obtained, as already described, one screwed cylinder; this is removed, and another of the same size is put into the machine. The same operation is performed on it as on the last; but it is not screwed to a full thread, the sharp cutter being removed when the spaces and threads are of an equal size, and a square cutter is put in its place, by means of which is obtained what is technically termed a square thread, as shewn in fig. 4. In the same manner, a third and a fourth cylinder are screwed, each being successively a degree smaller than the preceding. The small frame holding the cutter is now removed, and replaced with dies, a set of which is to be screwed with each of the above cylinders. When the dies are to be screwed, they are placed in the die-frame with one of the cylinders already made, and pressed against it by the screws G *g*, until they are fully screwed. After this, they are replaced with another cylinder, and another set of dies, which are likewise to be screwed. The same operation is performed with a third and a fourth set; (the first set of dies *only*, having a sharp thread, the other set having square threads,) after which they are to be tempered. The headstock is now removed to the left, to admit the cylinder of which the perfect screw is to be formed, and fastened at any required distance, the machine being constructed to cut a screw above three feet in length. The cylinder being placed between the sharp dies, which are gently pressed by the screws G*g*, is turned round by the handle, until the die-frame reaches the left hand of the cylinder; it is then turned in the contrary way, and worked in the same manner as when using the cutter. When a square-thread screw is to be made, the sharp dies must be removed after the indentation is sufficiently deep to admit the square dies, which are to be substituted for the former; when these have cut the screw to a considerable depth, a smaller set of square dies is taken in succession, until the screw is finished.

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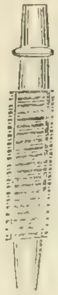
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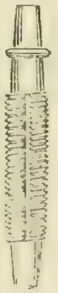
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10

N. B. Figs. 7 and 8 represent a small stock made of steel, and hardened, for holding the cutter while sharpening. Figs. 9 and 10 represent an edge and side view of the cutter. Figs. 5 and 6 represent the dies.

SCRIBE, a principal officer in the Jewish law, whose business it was to write and interpret scripture.

SCRIBING, in Joinery, the joining two pieces of wood together, when the surfaces are irregular, so that the protuberances in the one part shall suit with exactness the indentations of the other.

SCRIPTURE, Writing, the revelation of God to man, as contained in the Bible. All profane scoffing at the holy scripture, or exposing any part thereof to contempt or ridicule, is punishable by fine and imprisonment. 1 Haw. 7.

SCRIVENER, one who lends money out at interest. Also, one who transacts money matters between contracting parties.

SCROFULA, a disease commonly called the *king's evil.* The name scrofula was derived from an opinion that swine were particularly subject to this affliction.

SCROLL, in Heraldry, is the ornament placed under the escutcheon, containing a motto or short sentence, alluding sometimes to the bearings, or the bearer's name; sometimes expressing somewhat that is divine or heroic, and sometimes what may be deemed heroical.

SCRUPLE, a weight equal to the third part of a drachm, or to twenty grains.

SCRUTORE, or Scrutoire, a kind of cabinet, with a door or lid opening downward, for the conveniency of writing.

SCUD, a name given by seamen to the low and thin clouds which are most swiftly wafted along by the wind in dull weather.

SCUDDING, the movement by which a ship is carried precipitately before a tempest, and is either performed with a sail extended on her foremast, or, if the storm is excessive, without any sail, which is then called, scudding under bare poles. In sloops and schooners, and other small vessels, the sail employed for this purpose is called the square-sail. In large ships it is either the foresail at large, reefed, or with its goosewings extended, according to the degree of the tempest; or it is the fore-topsail close reefed, and lowered on the cap, which last is particularly used when the sea runs so high as to becalm the foresail occasionally, a circumstance which exposes the ship to the danger of broaching-to. As a ship flies with amazing rapidity through the water whenever this expedient is put in practice, it is never attempted in a contrary wind, unless when her condition renders her incapable of sustaining the mutual efforts of the wind and waves any longer on her side, without being exposed to the most imminent danger. The hazards to which this operation subjects a vessel are,—a pooping sea, the difficulty of steering to prevent broaching-to, and the want of sufficient sea-room. A sea striking the ship violently, may dash it inwards, by which she must inevitably founder; in broaching-to suddenly, she is threatened with being immediately overset; and for want of sea-room, she is endangered by shipwreck on a lee-shore.

SCULL, among sailors, a kind of short oar, the loom of which is only equal in length to half the breadth of the boat, whereby two may be managed by one man, one on each side. *To Scull,* is to cause a boat to advance by a particular method of managing a single oar over the boat's stern.

SCULLER, a term denoting a boat rowed by one man with two short oars, or rather sculls; it is used in contradistinction to Oars, which signifies a boat rowed by two men with oars.

SCULPONÆ, among the Romans, a kind of shoes worn by slaves. They were hollow blocks of wood, like French sabots.

SCULPTURE, is an art, in which, by means of taking away, or adding to matter, all sorts of figures are formed, either in clay or wax, wood, marble, or other stones, or metal. The art of sculpture, in its most extensive sense, comprehends not only carving in wood, stone, or marble, but also enchasing, engraving in all its kinds, and casting in bronze, or lead, wax, and plaster of Paris, as well as modelling in clay, wax, or stucco.

SCUM, a light excrement arising from liquors when briskly stirred; also called foam, froth, or spume. Scum is also used for the impurities which a liquor by boiling casts up to the surface, and likewise for those taken from metals in a state of fusion. These are also called tutty and scoria.

SCUMA, the scales of any metal, and particularly applied to the small flakes flying off from hot iron under the hammer.

SCUPPERS, certain channels cut through the water-ways and sides of a ship at proper distances, and lined with sheet-lead, in order to carry the water off the deck into the sea.

SCUPPER-HOSE, a leathern pipe or tube nailed round the outside of the scuppers of the lower decks, and which by hanging down prevents the water from entering when the ship inclines under a pressure of sail. *Scupper-Nails,* have very broad heads, so as to retain a great quantity of the hose under them. *Scupper-Plugs,* are used to stop the scuppers occasionally.

SCURF, small exfoliations of the skin which occur after a slight inflammation, and when a new exterior of skin is forming under that which is thrown off.

**SCURRA**, an ancient name given to the jackdaw.

**SCURVY**, a formidable and often fatal disease, arising from salt provisions, imperfect nutrition, and other causes. Seamen, during long voyages, are particularly subject to it; but it is also an endemic of the land. Some have thought that it has an affinity to the leprosy, the degree depending on climate, &c.

**SCUTAGE** was anciently a tax imposed on such as held lands, &c. by knight's service, towards furnishing the king's army.

**SCUTARIUS**, among the Romans, a shield-maker; also it denotes a life-guard of the emperor, because his body was covered with armour.

**SCUTTLE**, in Agriculture, a shallow basket used in barns and in stables for various purposes. The sizes are indefinite.

**Scuttle**, a small hatchway, or hole, cut for some particular purpose through a ship's decks or sides, or through the coverings of her hatchways, and furnished with a lid which firmly encloses it when necessary.

**SCUTTLING**, the act of cutting large holes through the bottom, sides, or decks of a ship, for various occasions, particularly when she is stranded or overset, and continues to float on the surface, in order to take out the whole or part of the cargo, provisions, stores, &c. *To Scuttle a Ship*, to sink her by making holes through her bottom.

**SCUTTLE-BUTT**, or Cask, is a cask having a square piece sawn out of its bilge, and lashed upon the deck. It is used to contain the fresh water for daily use, whence it is dipped out with a leaden can.

**SCUTUM SOBIESKI**, or Sobieski's *Shield*, a constellation formed by Hevelius: the stars are seven; but four of these are enumerated in the Aquila, in the Britannic catalogue.

**SCYBOLA**, in Medicine, a name given to the contents of the bowels when hard, dry, and formed into small masses resembling the excrement of sheep.

**SCYPHUS**, among the Romans, a very large drinking cup, which was sometimes called the cup of Hercules.

**SCYRA**, a fine imposed on such as neglected to attend the Scyregemot courts, which all tenants were bound to do.

**SCYREGEMOT Court**, a county court, anciently held twice a year, by the bishop of the diocese and the alderman or sheriff, in which both the ecclesiastical and temporal laws were given in charge to the county.

**SCYTHE**, Sithe, or *Sythe*, an edge-tool used in mowing, being a crooked blade joined nearly at right angles to a long pole or handle. This instrument is well known, and universally valued.

**SEA**, is a great collection of water; by sailors, however, this word is variously applied to a single wave, to the agitation produced by a multitude of waves in a tempest, or to their particular progress or direction. Thus they say, we shipped a heavy sea—there is a great sea in the offing—the sea sets to the southward. Hence also a ship is said to head the sea when her course is opposed to the setting or direction of the surges. *A long Sea*, implies a uniform and steady motion of long and extensive waves. *A short Sea*, is when they run irregularly, broken, and interrupted, so as frequently to break over a vessel's bow, side, or quarter.

Sea-*Boat*, a vessel that bears the sea firmly, without labouring heavily, or straining her masts, or rigging. *Sea-Breeze*, the current of air which blows during the day from the sea upon the shore in warm climates. *Sea-Clothes*, are jackets, trowsers, &c. *Sea-Coast*, the shore of any country, or that part which is washed by the sea. *Sea-Legs*, implies the capacity of walking on a ship's decks when she pitches or rolls about at sea.

Sea *Kale*, the common name of a highly nutritious and palatable vegetable, now much cultivated, and greatly esteemed.

Sea-*Mark*, a point or conspicuous object distinguished at sea; they are of various kinds, as promontories, steeples, ruins, trees, &c. and are very beneficial by informing vessels of their situation on the coast.

Sea-*Port*, a haven near the sea, as distinguished from one which is situated up a river.

Sea-*Room*, implies a sufficient distance from land, rocks, or shoals, wherein a ship may drive without danger of shipwreck.

Sea-*Salt*, muriate of soda.

Sea-*Weed*, a sort of herb or tangles floating on the surface of the sea, or washed upon the sea-coast.

**SEAL**, a puncheon, or piece of metal, or other matter, usually either round or oval, whereon are engraven the arms, device, &c. of some prince, state, community, magistrate, or private person, often with a legend or subscription, the impression whereof in wax, serves to make acts, instruments, &c. authentic. Before the time of William the Conqueror, the makers of all deeds only subscribed their names, adding the sign of the cross, and a great number of witnesses; but that monarch and the nobility used seals with their arms on them, which example was afterwards followed by others. The colour of the wax wherewith this king's grants were sealed was usually green, to signify that the act continued fresh for ever, and of force. A seal is absolutely necessary in respect of deeds, because the sealing of them makes persons parties thereto, and without being sealed they are void in law.

**SEALER**, an officer in chancery, appointed by the lord chancellor, or keeper of the great seal, to seal the writs and instruments there made in his presence.

**SEALING**, in Architecture, the fixing a piece of wood or iron in a wall with plaister, mortar, cement, lead, and other solid binding.

**SEAM**, or Seme, of corn, is a measure of eight bushels.

Seam *of Glass*, the quantity of 120 pounds, or 24 stones, each five pounds weight. The seam of wood is a horse-load.

**SEAMAN**, or Seafaring-Man, a person trained to the occupation of a mariner or sailor. The principal articles required in a common sailor are, that he should be able to steer, to sound, and to manage the sails, by setting, reefing or furling them; he is then called an able seaman.

Seamen, in Law: by various statutes, sailors having served the king for a limited time, are free to use any trade or profession, in any town of the kingdom. By 2 George II. c. 36, made perpetual by 2 George III. c. 31, no master of any vessel shall carry to sea any seaman, his own apprentice excepted, without first entering into an agreement with such seaman for his wages; such agreement to be made in writing, and to declare what wages such seaman is to receive during the whole of the voyage, or for such time as shall be therein agreed upon; and such agreement shall also express the voyage for which such seaman was shipped to perform the same, under a penalty of £10 for each mariner carried to sea without such agreement, to be forfeited by the master to the use of Greenwich Hospital. This agreement is to be signed by each mariner within three days after entering on board such ship, and is, when executed, binding on all parties.

**SEAMS**, the intervals between the edges of the planks in the decks and sides of a ship, or the places where the planks join together; these are always filled with a quantity of oakum, and covered with pitch, to prevent the entrance of the water. *Seam* also implies that part where two edges of canvass are laid over each other and sewed down.

**SEARCH WARRANT**, in Law, a kind of general warrant issued by justices of the peace, for searching all suspected places for stolen goods. Proper grounds, however, must be shewn for suspicion, before the warrant can be obtained. The name and place also must be specified, general warrants having long since been declared illegal.

**SEARCHER**, an officer of the customs, whose business it is to search and examine all ships outward bound, to see whether they have any prohibited or uncustomed goods on board.

**SEASONINGS**, in the West Indies, a kind of ague which strangers endure on their coming to the islands.

**SEASONS**, in Cosmography, contain portions of the year distinguished by the signs of the zodiac which the sun enters. Spring, summer, autumn, and winter, are their general denominations.

Seasons, *Terrestrial Globe, for Illustrating the*.—This terrestrial globe, mounted on a new principle, the invention of Mr. Christie, a teacher of mathematics, is so constructed as familiarly to illustrate the earth's annual and diurnal motions, the diversity of the seasons, the sun's apparent progress in the ecliptic, his increase and decrease of declination, and the comparative lengths of days and nights at different times of the year on the same part of the earth, and at the same time of the year on different parts of the earth; as well as to solve all the problems usually performed on a terrestrial globe. Scarcely a school, or a private family where there are children to instruct, is without a pair of globes; on the use of which different writers have proposed many problems, which, though simple in themselves, have often become very difficult to learners, from the inadequacy of the common globes to illustrate them. Among these are the greater part, if not all those relating to the sun and earth jointly. Many of the difficulties have probably arisen from the inconsistency of representing a place in motion while its horizon is at rest, which has hitherto been done by globe-makers. To remedy this, some writers have recommended the pole to be elevated as many degrees above the horizon as are equal to the sun's declination, instead of the latitude of the place. But this plan is also defective in some particulars; for, what the learner was taught to call the horizon, and what the author at the very time calls the horizon, ceases to be so when the pole is elevated for the sun's declination: besides, the change in the length of days and nights is, by this method, represented to arise from the alternate motion of the poles backwards and forwards with respect to the sun. To a terrestrial globe, the geographer owes his first correct notion of the earth's form; of the relative sizes and situations of places on its surface; of its natural divisions into continents and islands, oceans and seas; and of its artificial divisions into empires, kingdoms, states, and provinces; and when mounted on this plan, it will greatly assist the teachers of astronomy in illustrating the motion of a planet about the sun.

The inventor was led to this discovery by having frequently found considerable difficulty in giving to his younger pupils correct notions of the earth's annual motion, and the consequent phenomena; nor does it appear that others have found the common globes sufficient for this purpose. Ferguson and Bonnycastle recommended a wire circle to be held or fixed in an oblique position, a candle to be placed in the centre, and a small globe suspended by a twisted thread to be carried round the wire circle by the hand. The untwisting of the thread is intended to represent the earth's diurnal, and the progress along the wire its annual motion. Keith sometimes employs the same method, but says, that it "does not so clearly shew the obliquity of the earth's axis to the plane of its orbit," as one which he describes in his Treatise on the Use of the Globes.

The apparatus contrived by Mr. Christie fully supplies these deficiencies; exhibiting a clear and intelligible view of the earth's passing through one side of the zodiac while the sun appears to pass through the opposite. It is neither so complicated nor so expensive as to prevent its being generally introduced, and it will greatly facilitate the pupil's progress in what is called the *use of the globes.* Subjoined is a description of the engraving which will be found in the plate of *Artificial Globes, Celestial and Terrestrial*, fig. 8.

The chief novelties of this mounting are, a lamp covered by a hollow sphere of ground glass, representing the sun, round which a terrestrial globe moves, in a circle, whose plane makes with the horizon an angle of 23½°; two parallel levers, supporting the globe, and its counterpoise P; an horizon, *h h*, and a meridian, *i m*, both turning with it on its axis: a terminator, *t r*, distinguishing the parts of the earth enlightened from those in darkness; and a claw-feet pillar or stand, T, supporting the whole. Into the top of the stand, a piece of strong steel wire, *w*, is screwed, and its upper end is bent 23½° from the perpendicular, corresponding with the inclination of the earth's axis to the plane of its orbit. On the bent part of the wire is fitted a brass collar, (but invisible in the engraving,) from the opposite sides of which two points extend about an inch: these points move in centres fixed in the upper lever; and this motion permits the same side of the lever to continue upwards, while its ends are alternately elevated and depressed by the motion of the collar on the bent wire. The lower lever moves freely on the wire immediately under the bent part. The levers are connected at their ends by two pieces of brass, each piece having two square holes in it, to admit the ends of the levers. Into the opposite sides of each hole are screwed two steel points which move in centres, permitting the connecting pieces to continue perpendicular, while they are elevated and depressed with the ends of the levers. On the top of the piece connecting the long ends is screwed a brass tube, *a b*, containing the axis of a terrestrial globe, produced and sharpened to a conical point (at *b*), on which it rests and turns. On the lower end of the other connecting piece is screwed a leaden weight P, which balances the globe, and preserves the parallelism of its axis during its annual motion. On the top of the bent wire is fixed a circular board *d c*, on which are delineated the signs of the zodiac, days of the month, &c.; the board declines 23½° from the level, representing a portion of the plane of the earth's orbit; and a pointer, *c*, from the brass collar, moves with the levers along the circles of signs and months, shewing the sun's place or day of the month, corresponding with any position of the globe, or the position of the globe corresponding with any place of the sun or day of the month. A silk line extends round the circumference of this board and round a pulley on the axis of the globe, at *b*, to produce the diurnal motion; the line is conveyed from the board to the axis through a brass tube *b d*, and after passing the pulley on the axis, it is carried round another pulley, (near *b*,) which being fixed to the end of the upper lever, preserves an equal tension on the line. Into the board immediately over the centre of motion of the levers, is screwed a stem supporting a lamp, with its ground glass cover. The remaining parts, *viz.* the hour circle, the meridian, the horizon, and the terminator, are more immediately connected with the globe. The hour circle, *e o*, is fitted on the axis below the globe, sufficiently stiff to preserve its adjustment, when set to the meridian of any place. The hour is indicated on it by a pointer, (at *o*,) attached to the brass tube, *a*. The meridian is a ring of brass attached to the poles, with its flat surface towards the globe; one semicircle of it is divided into degrees, and numbered from the equator towards the poles, for finding the latitudes of places, declination of the sun, &c. The horizon is a thin slip of brass, one end of which fits into a socket fixed on the other: it is attached to a wire which moves up or down with it in a groove near the edge of the meridian, representing at pleasure the rational horizon of any place; and it is divided into degrees and points of the compass, for finding the sun's azimuth, amplitude, &c.; it is necessary to separate the ends of the horizon when it is changed from N. to S. or from S. to N. latitude. Both meridian and horizon are turned with the globe on its axis, so that, when they are adjusted to the latitude and longitude of any place, they retain their adjustment till an alteration is required. In the pole of the horizon, a pointer, *i*, is fixed on the wire, shewing the zenith, to which a quadrant of altitude is occasionally attached. The terminator is sufficiently large to permit the globe with the other circle to turn within it; this circle is made a little concave, to reflect light on those parts which receive but little of the direct light, and to mark more distinctly the difference between the light and dark hemispheres; it is supported by two pivots, (one of which is seen at *r*,) fixed in its opposite sides, even with the equator: these pivots are fitted into and move in the ends of a strong semicircular wire, *r n*, which is supported behind the globe with a very strong piece of bent wire, *n a*, extending from the brass tube containing the axis; and the lower part of the terminator is cut, to permit its passing the axis at the south pole, which it does when the sun's declination changes from north to south, or from south to north. From this lower part a circular wire, *o s*, extends 90° upwards, on the top of which is fixed a pointer, *s*, representing a central ray from the sun: this pointer shews the sun's declination, azimuth, amplitude, altitude, and the place where he is vertical at a given time: from the top, a similar wire *f g*, extends 90° downwards behind the globe, where it is attached by a vertical piece, *g h*, to the upper lever produced; the lower end of the vertical wire is the same distance from the piece connecting the levers as its upper end is from the centre of the globe; thus forming a kind of parallelogram, which in some positions of the globe takes the form of a rectangle, and in others that of a rhomboid. This contrivance preserves the face of the terminator constantly towards the lamp, and alternately exposes to its light the north and south poles during its annual motion.

*Illustrations.*—To illustrate the earth's annual and diurnal motions, nothing more is necessary than to move the pointer slowly along the circles of months and signs, and the globe will be perceived to descend 23½° below the level of the sun on one side, and to rise as many degrees above his level on the other, while the axis remains perpendicular to the horizon, or parallel to itself—the globe at the same time turns on its axis from W. to E. representing the diurnal motion. During the annual motion, it will be perceived that, when the pointer is at the first degree of Aries on 21st March, the light extends from pole to pole; that all places continue equal portions of time in the light and dark hemispheres; that a straight line joining the centres of the sun and earth would pass through the equator, and consequently the sun has no declination; and that the central ray is crossing the equator from south to north. From this time the earth will be seen gradually descending below the level of the sun, and the central ray gradually rising north of the equator till it reaches the tropic of Cancer, while the pointer, *c*, has passed through Aries, Taurus, Gemini, and reached the first of Cancer on the 21st of June; when it will be perceived that a straight line joining the centres of the sun and earth would pass through the tropic of Cancer, and consequently the sun's declination is 23½° north; that his light extends 23½° over the north pole, but does not reach the south by the same number of degrees; that the diurnal motion does not remove from his light any part of the north frigid; and that all places in north latitude will have their days longer than their nights, while all places in south latitude will have the reverse.

From this period the earth will be seen gradually rising towards the level of the sun, and the central ray descending till it again reaches the equator, during which time the pointer, *c*, will be seen passing through Cancer, Leo, and Virgo, till it reaches the first of Libra on the 23d of September, when the observations which were made on the 21st of March will apply, except that the central ray will now be seen crossing the equator from north to south. From this time the earth will be seen gradually ascending above the level of the sun, while the pointer, *c*, passes through Libra, Scorpio, and Sagittarius, till it reaches the first of Capricornus, when the central ray will have descended to the tropic of Capricornus on the 21st of December. It will now be perceived that a straight line joining the centres of the sun and earth, would pass through the tropic of Capricornus; that the sun's declination is 23½° south; that his light extends 23½° over the south pole, but does not reach the north by the same number; that the earth's diurnal motion does not expose to his light any portion of the north frigid zone, nor remove from it any portion of the south frigid zone; and that all places in the southern hemisphere have longer days than nights, while all places in the northern hemispheres have the reverse. From this time the earth will be seen gradually descending again, while the pointer, *c*, passes through Capricornus, Aquarius, and Pisces, till it again reaches Aries. The engraving, which is a perspective view, represents the position when the sun is in the 5th degree of Aquarius, on the 26th of February.

**SEBACIC ACID**, an acid supposed to have been found in fat of a strong disgusting odour.

**SEBATES**, salts formed of the sebacic acids, and alkalies, earths, &c.

**SECALE**, Rye, a genus of the digynia order, in the triandria class of plants, and in the natural method ranking under the fourth order, gramina. Rye is commonly sown on poor, dry, limestone or sandy soils, where wheat will not thrive. By continuing to sow it on such a soil for two or three years, it will at length ripen a month earlier than that which has been raised for years on strong cold ground.

**SECANT**, in Geometry, is a line that cuts another, or divides it into two parts.

**SECEDERS**, an appellation comprehending those who are dissenters from the established church of Scotland. This secession took place under John Glas in 1727.

**SECOND**, in Geometry, Chronology, &c. the sixtieth part of a prime or minute, whether of a degree, or of an hour; it is denoted by two small accents, thus (″).

Second, in Music, an interval of a conjoint degree.

**SECONDARY**, in general, something that acts as second, or in subordination to, another.

Secondary *Rocks*, are those in which numerous remains of vegetables and animals occur. This division contains sandstone, coal, stratified limestone, chalk, &c. Pebbles and water-worn fragments of rocks belonging to the former divisions, are commonly found in many of the secondary rocks: hence it is inferred, by geologists, that they have been formedat a later period, and hence this class receives its name.

**SECRETARY**, an officer who, by his master's orders, writes letters, despatches, and other instruments, which he renders authentic by his signet.

**SECRETION**, in the animal economy, the separation of some fluid mixed with the blood by means of the glands.

**SECTION**, in Geometry, denotes a side or surface appearing, of a body or figure cut by another; or the place where lines, planes, &c. cut each other.

Section *of a Building*, is the same with its profile; or a delineation of its heights and depths raised on a plane, as if the fabric was cut asunder to discover its inside.

**SECTOR**, in Geometry, is a part of a circle, comprehended between two radii and the arch; or it is a mixed triangle, formed by two radii and the arch of a circle.

**SECUNDINES.** After-birth.

**SEDAB**, in Botany, a name given by the Arabian physicians to the wild or mountain rue, a plant common in Greece, Syria, and other places.

**SEDATIVE**, in Medicine, nearly synonymous with anodyne; medicines, calculated to assuage pain.

**SEDGE** Grasses, a name given to various sorts of grasses of the poor carnation kind. They are hardy in their nature, prevail much in crude heavy land, and are rarely eaten by any cattle.

**SEDIMENT**, the settlement or dregs of any thing; or that heavy portion of a fluid body which sinks to the bottom of a vessel.

**SEDINA**, a word used by some writers to express dragon's blood.

**SEDITION**, among Civilians, is used for a factious commotion of the people, or an assembly of a number of citizens without lawful authority, tending to disturb the peace and order of society.

**SEED**, in Botany, the essence of the fruit of every vegetable. Linnæus denominates it to be a deciduous part of the plant, containing the rudiments of the new vegetable, and fertilized by the sprinkling of the male dust. Plants are furnished with one seed, as the sea-pink; or two, as in umbelliferous plants; or three, as in the spurge; or many, as in the ranunculus. &c. The shape, structure, and sides of seeds, are various. Linnæus denominates seeds the eggs of plants; and the fecundity of plants is often astonishing: there are 4000 seeds in a single sun-flower; more than 30,000 in a poppy; and in a single tobacco plant 360,000 have been enumerated. The annual produce of a single stalk of spleenwort has been estimated to be a million of seeds. Plants are disseminated in various methods: some are carried along by rivers and torrents many hundred miles from their native soil, and cast upon a very different climate, to which, however, by degrees they render themselves familiar. Some are formed by wings to be borne before the wind to distant places. Birds, squirrels, &c. swallow seeds, and void them whole and fit for vegetation, and thus disseminate them. There are others that disperse themselves by an elastic force, that resides either in the "calyx," as in oats and the ferns; in their "pappus," as in the centaurea crupina, or in their "capsule," as in the geranium.

**SEGGARS**, in the manufacture of porcelain and pottery, are cases formed of coarse clay, capable of sustaining the required heat without fusion; in which different kinds of earthenware are baked.

**SEGMENT** of a Sphere, is a part of a sphere terminated by a portion of its surface, and a plane which cuts it off, passing somewhere out of the centre; being more properly called the section of a sphere.

**SEIGNORAGE**, signifies the right or due belonging to a seigneur or lord; but it is particularly used for a duty belonging to the prince for the coinage of money, called also coinage: which under our ancient kings was five shillings for every pound of gold brought in the mass to be coined, and a shilling for every pound weight of silver. At present the king claims no seignorage at all.

**SEINE**, the name of a large fishing-net.

**SEISIN**, in Law, signifies possession.

**SEISE**, Sease, or *Seaze*, in the sea language, is to make fast or bind, particularly to fasten two ropes together with rope-yarn.

**SEIZING**, the operation of fastening any two ropes or different parts of one rope together with a small line or cord. *Seizing*, implies also the cord which fastens them.

SEIZURE, in Commerce, an arrest of some merchandise, moveable or other matter, either in consequence of some law, or of some express order of the sovereign.

SELENIUM. A new substance discovered by M. Berzelius, which has the properties of a metal combined with those of sulphur to so great a degree, that it might be supposed to be a new species of sulphur. In its reguline state, it has a brilliant metallic lustre on the external surface, with a tinge of red; the fracture is vitreous like that of sulphur, but with a very brilliant lustre, of a gray colour.

SELENOGRAPHY, a branch of cosmography, which describes the appearances of the moon, as geography does those of the earth. The invention of telescopes has much improved this branch of human knowledge.

SELF-LOVE, in Ethics, that principle which leads a person to desire and pursue his own happiness. It is contradistinguished from benevolence. Few topics have been more fruitful in generating disputes, respecting its definition, application, and qualities, and few have been left more undecided.

SELL, in Building, is of two kinds, viz. ground-sell, which denotes the lowest piece of timber in a timber building, and that on which the whole superstructure is raised; and the window-sell, called also window-soil, the bottom piece in a window frame.

SELTZER Water, the name of a mineral water of Germany, which rises near Seltzer, about four miles from Frankfort on the Mayne. It is much used in England, and many other countries, for its medicinal virtues. It has been found serviceable in scorbutic, cutaneous, and putrid disorders, and is strongly recommended in various other complaints.

SELVAGE, a sort of hank or skein of rope-yarn, used to fasten round any rope as a shroud or stay, by which to hook a tackle, in order to set it up.

SEMEN, a substance prepared by nature for the reproduction and conservation of the species both in animals and plants. The peculiar liquid secreted in the testes of males, and destined for the impregnation of females, is so named. *See* Seed.

SEMICIRCLE, in Geometry, half a circle, or that figure comprehended between the diameter of a circle and half the circumference.

SEMICOLON, in Grammar, one of the points or stops used to distinguish the several members of sentences from each other (;)

SEMI-DIURNAL. Of any of those circles which the sun appears to form each daily revolution, that portion which is above the horizon is called the diurnal arch, and that which is below the horizon is called the nocturnal arch, the halves of which are called the semi-diurnal and the semi-nocturnal arches

Semi-*Metals*, a term that expresses those metallic substances not possessing ductility and malleability, these properties being deemed characteristic of real metals.

SEMINARY. *See* School.

Seminary, in Gardening, is a place allotted for raising plants from seed, and keeping them till they are fit to be removed into the garden or nursery.

SEMITA LUMINOSA, a name given to a lucid track in the heavens, which, a little before the vernal equinox, or after the autumnal, may be seen about six in the evening, extending from the western edge of the horizon up towards the Pleiades. This stream of light bears some resemblance to the tail of a comet.

SENA, or Senna, or the *Egyptian Cassia*, in the Materia Medica, a purgative leaf much used in draughts, and compositions of that description. It is a native of Egypt; that of the best quality is said to grow in the valley of Basabras, or of Nubia. Senna of an inferior kind grows in the Levant, and about Florence. Its operation is not violent, and it enters into the compound of various medicines.

SENATE, an assembly or council of the principal inhabitants of a state, who have a share in the government. Senates are differently formed according to the political constitutions of various countries.

SENATOR, a member of a senate.

SENDING, a naval term, expressing the act of a ship pitching precipitately into the hollow or interval between two waves,

SENEKA, or Rattlesnake *Root*. This plant is a native of Virginia, Pennsylvania, and Maryland, and is now cultivated in some of our gardens. The root is perennial, the thickness about that of a man's little finger, and its length about four or five inches, being variously contorted and twisted. It has only of late been brought into use among us; but it is thought worthy of great regard. A *knowledge* of its virtues was first taught the Europeans by the Senegal Indians, who esteemed it a sovereign remedy against the bite of the rattlesnake; in which character it has been found efficacious.

SENNIT, a kind of flat braided cordage used for various purposes, and formed by plaiting five or seven rope-yarns together.

SENSATION, in Physiology, is a general term denoting the effect produced in the mind by the impression of external bodies on our organs of sense, namely, seeing, hearing, feeling, tasting, and smelling.

SENSE, sometimes means the organs of sensation, and at other times it is used for understanding, judgment, and conscience.

SENSIBILITY, the power of receiving an impression, and transmitting it to the brain, so as to occasion an acute sensation or feeling.

SENSITIVE Fluid, a fluid which is supposed to preserve animals from corruption. It is presumed to pass through the nervous tubes, and to convey the impression to the sensorium.

Sensitive *Plant*. *See* Mimosa.

SENSORIUM, the part of man which feels and perceives, the common centre to which sensations are conveyed, and from which volitions emanate.

SENTENCE, in Grammar, a period or set of words comprehending some perfect sense or sentiment of the mind.

Sentence, in Law, a judgment passed in court by the judge upon some process either civil or criminal.

SENTINEL, in War, a private soldier placed in some post to watch the motions of an enemy, to prevent surprises, and to stop such as would pass without orders, or shewing who they are.

SEPIA, the cuttle-fish, a genus belonging to the order of vermes mollusca. There are eight brachia interspersed on the interior side with little round serrated cups, by the contraction of which the animal lays fast hold of any thing. Besides these eight arms, it has two tentacula longer than the arms, and frequently pedunculated. The mouth is situated in the centre of the arms, and is horned and hooked. The eyes are below the tentacula, towards the body of the animal. The body is fleshy, and received into a sheath as far as the breast. Their food are tunnies, sprats, lobsters, and other shell-fish. With their arms and trunks they fasten themselves to resist the motion of the waves. Their beak is like that of a parrot. The females are distinguished by two paps. This animal was esteemed a delicacy among the ancients; and is eaten at present by the Italians. The bony scale on the back is that which is sold in the shops, and which, when reduced to fine powder, is reckoned excellent for the teeth, as well for keeping them white as for preserving them. It is also used as pounce. These animals have the power of squirting out a black fluid resembling ink, which is said to be an ingredient used in the composition of Indian ink.

SEPS, in Zöology, the name of a peculiar kind of lizard, between that genus and the snakes. It appears as a serpent with feet. Its bite is said to be followed by instant putrefaction and speedy death.

SEPTEMBER, the ninth month of the year, reckoned from January, and the seventh from March, whence its name, *viz.* Septimus, seventh.

SEPTICS, among Physicians, a name given to all such substances as promote putrefaction.

SEPTUAGINT, the name given to a Greek version of the books of the Old Testament, from its being supposed to be performed by seventy-two Jews, who are usually called the seventy interpreters, because seventy is a round number.

SEPULCHRE, a tomb or place appropriated for the interment of the dead.

SEQUESTRATION, is the separating or setting aside of a thing in controversy, from the possession of both those who contend for it. A sequestration is also a kind of execution for debt, especially in the case of a beneficed clerk, of the profits of the benefice to be paid over to him that had the judgment, till the debt is satisfied.

**SERAGLIO**, denotes the palace of a prince or lord. At Constantinople they say the seraglio of the ambassador of England, France, &c. In a more eminent sense, the Turks apply the term to the palace of the grand seignior, where he keeps his court, where his women are kept, and where the youth are trained up for the chief posts in the empire. The whole building is in a triangular form, about three Italian miles in circuit. That part of the seraglio in which the women reside is called the *Harem*.

**SERAPH**, or Seraphim, supposed to be an angel of the first or highest rank, and to be more inflamed with divine love than others, and hence the name, which signifies to burn, to inflame.

**SERENADE**, an evening concert given by a lover under the window of a room in which his mistress resides.

**SERGE**, in Commerce, a woollen stuff manufactured in a loom, of which there are various kinds, denominated either from their different qualities, or from the places where they are wrought; the most considerable of which is the London serge, which is highly valued abroad.

**SERIES**, in general, denotes a continued succession of things in the same order, and having the same relation or connexion with each other.

Series, *Infinite*, is a series consisting of an infinite number of terms, that is, to the end of which it is impossible to come; so that let the series be carried on to any assignable length, or number of terms, it can be carried yet farther, without end or limitation.

**SERICH**, the name of a seed used in the food of the Egyptian Coptics. It is produced by an herb called *scinsim*, and is pounded and put into oil. In this they dip their bread, which is always new, being baked in small cakes, as often as they eat. Raw onions are added to this repast.

**SERGEANT**, or Serjeant, in War, is an inferior officer in a company of foot, or troop of dragoons, armed with a halberd, and appointed to see discipline observed, to teach the soldiers the exercise of their arms, and to order, straighten, and form ranks, files, &c.

Serjeant at *Law*, is the highest degree taken in that profession, as that of a doctor is in the civil law. To these serjeants, as men of great learning and experience, one court is set apart for them to plead in by themselves, which is the court of common pleas, where the common law of England is most strictly observed; yet, though they have this court to themselves, they are not restrained from pleading in any other courts. The judges cannot be elevated to that dignity till they have taken the degree of serjeant at law. They are called brothers by the judges, who hear them next to the king's counsel; but a king's serjeant has precedence of all but the attorney and solicitor general. These are made by the king's mandate, or writ.

**SERJEANTY**, signifies in law a service that cannot be due from a tenant to any lord, but to the king only; and it is either grand serjeanty, or petit serjeanty.

**SERMON**, a discourse delivered in public, for the purpose of religious instruction and moral improvement. The present mode of delivering sermons may be traced to the book of Nehemiah, chap. viii. 4.

**SERMONIUM**, a kind of interlude, which, in ancient times, the inferior clergy, assisted by boys, used to act in the body of the church, on certain festivals. The representative selections were made according to the occasion.

**SERPENT**, in Music, a wind instrument of the bassoon kind, deriving its name from its serpentine figure.

Serpent, in Mythology, was a symbol of the sun. He is represented as biting his tail, having his body in a circle, indicating the apparent motion of that luminary round the globe. The serpent biting his tail, is likewise considered as an emblem of eternity. The serpent was, from time immemorial, an object of religious veneration and worship in Egypt; and in subsequent ages, was a symbol of medicine, and of Apollo and Esculapius, the gods which presided over it.

**SERPENTES**, in Natural History, an order of the Amphibia, containing seven genera; *viz.* Achrochordus, Amphisbæna, Anguis, Boa, Cœcilia, Coluber, Crotalus. Serpents are distinguished as footless amphibia—their eggs are connected in a chain—penis frequently double—they breathe through the mouth—are cast naked upon the earth, without limbs, exposed to every injury, but frequently armed with a poison the most deadly and horrible: this is contained in tubular fangs resembling teeth, placed without the upper jaw, protruded or retracted at pleasure, and surrounded with a glandular vesicle by which this fatal fluid is secreted; but lest this tribe should too much encroach upon the limits of other animals, the benevolent Author of nature has armed about a fifth part only in this dreadful manner, and has ordained that all should cast their skins, in order to inspire a necessary suspicion of the whole. The jaws are dilatable and not articulate, and the œsophagus so lax that they can swallow without any mastification an animal twice or thrice as large as the neck; the colour is variable, and changes according to the season, age, or mode of living, and frequently vanishes, or turns to another, in the dead body; tongue filiform, bifid; skin reticulate. The distinction between the poisonous and innoxious serpents, is only to be known by an accurate examination of their teeth; those which are poisonous being always tubular, and calculated for the injection of the poisonous fluid, from a peculiar reservoir communicating with the fang on each side the head. Serpents in cold and temperate climates conceal themselves during the winter in cavities beneath the surface of the ground, or in any other convenient places of retirement, where they become nearly or wholly in a state of torpidity. Some serpents are viviparous, as the rattlesnake; the viper, &c.: while the innoxious species are oviparous, depositing, as we have observed, their eggs in a kind of chain in any warm and close situation, where they are afterwards hatched. The broad undivided laminæ on the bellies of serpents are termed scuta, and the small or divided ones beneath the tail are called subcaudal scales, and from these different kinds of laminæ, the Linnæan genera are characterized.

**SERPENTINE.** This beautiful stone takes its name from its variegated colours being supposed to resemble a serpent's skin. It consists of silica 32, magnesia 37·24, alumina 0·5, lime 10·6, iron 0·66, volatile matter and carbonic acid 14·16. The colours are most generally various shades of light and dark green, which are intermixed in spots and clouds: some varieties are red. When fresh broken, it has some degree of lustre, and a slight unctuous feel. It is harder than lime-stone, but yields to the point of a knife, and will receive a very high polish. When serpentine is found intermixed with patches of crystalline white marble, it constitutes a stone denominated verde-antique, which is highly valued for ornamental sculpture. Beautiful varieties of green serpentine occur in the isle of Anglesea, about six miles from the Paris copper mine.

**SERVANT**, a person who, in consideration of some stipulated remuneration, owes and pays limited obedience to the commands of another in the quality of master. An agreement, when the time is not specified, the law determines to be for one year; but by mutual agreement, a separation may take place at any intermediate stage. Servants are of various kinds and degrees, and several laws regulate their obedience, and the treatment they are entitled to expect.

**SERVICE**, in Law, is a duty which a tenant, on account of his fee, formerly owed to his lord.

**SERVING**, is the winding any thing round a rope to prevent it from being rubbed: the materials used for this purpose, which are called service, are generally spun-yarn, small lines, sennit, or ropes, varying in thickness, according to the dimensions of the rope to be served; sometimes leather, old canvass, &c. are used

**SERVITOR**, in the university of Oxford, a scholar or student who attends and waits on another for his keep there.

Servitors *of Bills*, such messengers of the marshal of the king's bench as are employed to summon men to that court. They are now commonly called *tipstaves*.

**SERUM**, a thin transparent liquor, which makes a considerable part in the mass of blood.

**SESAMUM**, *Oily Grain*, a genus of plants belonging to the class of didynamia, and to the order of angiospermia, and in the natural system ranking under the 20th order, luridæ.

**SESSION**, in Law, denotes a sitting of justices in court upon their commission: as the session of oyer and terminer, &c. *See* Quarter Sessions.

SET-OFF, in Law, is when the defendant acknowledges the justice of the plaintiff's demand on the one hand, but on the other sets up a demand of his own, to counterbalance that of the plaintiff, either in the whole or in part; as if the plaintiff sue for 10l. due on a note of hand, the defendant may set off 9l. due to himself for merchandise sold to the plaintiff, or for any other demand, the amount of which is ascertained in damages. The action in which a set-off is allowable upon the statutes 2 and 3 George II. c. 22 and 24, are debt, covenant, and assumpsit, for the non-payment of money; and the demand intended to be set up must be such as might be made the subject of one or other of these actions. A set-off, therefore, is never allowed in actions upon the case, trespass, replevin, &c. nor of a penalty in debt on bond conditioned for the performance of covenants, &c.; nor of general damages in covenant or assumpsit; but where a bond is conditioned for the payment of an annuity, a set-off may be allowed. A debt barred by the statute of limitations cannot be set off; and if it be pleaded in bar to the action, the plaintiff may reply the statute of limitations; or if given in evidence, on a notice of set-off, which is one mode of setting up this sort of counter-demand, it may be objected to at the trial.

SETS, in Agriculture and Gardening, a term applied to the cuttings or planted parts of potatoes, hops, liquorice, lavender, &c.

SETTEE, a vessel of two masts, equipped with triangular sails, commonly called lateen sails; these vessels are peculiar to the Mediterranean, and are generally navigated by Italians, Greeks, or Mahometans.

SETTING, in the sea language. To set the land or the sun by the compass, is to observe how the land bears on any point of the compass, or on what point of the compass the sun is. Also, when two ships sail within sight of one another, to mark on what point the chased bears, is termed setting the chase by the compass.

SETTLEMENT, Act of, a name given to a statute 12 and 13 W. III. cap. 2, by which the crown was limited to his present majesty's illustrious house, and by which some new provisions were added in favour of the subject, securing his liberty, and the rights of conscience.

SEWED, the situation of a ship which rests upon the ground; and while the depth of water around her is not sufficient to float her, she is said to be sewed by as much as is the difference between the surface of the water and the ship's floating-mark, or water-line.

SEWER, a passage or gutter made to carry water into the sea or a river, whereby to preserve the land, &c. from inundations, and other annoyances. The business of the commissioners of sewers, or their office in particular, is to repair sea-banks and walls, survey rivers, public streams, ditches, &c. and to make orders for that purpose,

SEX, something in the body which distinguishes male from female, and is common to both plants and animals.

SEXANGLE, in Geometry, a figure having six sides, and consequently six angles.

SEXAGESIMALS, or Sexagesimal Fractions, fractions whose denominators proceed in a sexagecuple ratio; that is, a prime, or the first minute $=\frac{1}{60}$; a second $=\frac{1}{3600}$; a third $=\frac{1}{216000}$. Anciently there was no other than sexagesimals used in astronomy, and they are still retained in many cases.

SEXTANT, in Mathematics, denotes the sixth part of a circle, or an arch comprehending sixty degrees.

Sextant, an instrument for taking altitudes and other angular distances; it is constructed on a principle similar to Hadley's Quadrant, but the arc, containing a sixth part of a circle, may be taken to 120°. Sextants are generally fitted with apparatus for ascertaining the angular distances, &c. in lunar observations.

SEXTON, a church-officer whose business is to take care of the vessels, vestments, &c. belonging to the church, and to attend the minister, churchwardens, &c. at church.

SEXUAL System, in Botany, denotes that system which is founded on a discovery, that in vegetables, as well as in animals, there is a distinction of sexes. This fact seems to have been partially received so early as the days of Herodotus; but it afterwards sunk into disrepute, and was nearly forgotten, until the diligence of modern observations placed its certainty beyond all reasonable doubt.

SHACK, an ancient feudal custom, which secures to the lord of the manor a right of pasturage in the lands of his tenants In Norfolk and Suffolk the lords of the manors still have shack during the six winter months. Shack is also applied to grain that is wasted in the fields during harvest.

SHACKLES, semicircular pieces of iron, sliding upon a round bar, in which the legs of prisoners are occasionally confined to the deck.

SHADOW, in Optics, a privation or diminution of light, by the interposition of an opake body; or it is a space where the light is either altogether obstructed, or greatly weakened by the interposition of some opake body between it and the luminary.

SHAFT, in Building, is the body of a column, and is so called from its straightness; it also has frequently the name of *fust*. The same term is likewise used for the spire of a steeple, and for the shank or tunnel of a chimney.

Shaft, in Mining, is a hollow passage sunk, in general, perpendicularly into the earth, to reach the ore. Shafts of this description are of various depths; some in Cornwall exceed two hundred fathoms.

Shaft, in Agriculture, is the handle of a tool or implement, such as a spade, fork, shovel, &c. In carts and waggons shafts are the parts or poles between which the hinder horses draw.

SHAGGE, or Shag, in Ornithology, a water-fowl of the cormorant kind, frequently found on the English shores, particularly on the northern parts.

SHAGREEN, or Chagreen, in Commerce, a kind of grained leather, prepared, as is supposed, of the skin of a species of squalus, or hound-fish, called the shagree, or shagrain, and much used in covering cases, books, &c.

SHAKES, and Shaky, terms frequently used by shipwrights and carpenters to denote the cracks or rents in any piece of timber, occasioned by the sun or weather.

SHALE, in Natural History, a variety of schistose clay. The acid emitted from shale during its calcination, uniting itself to the argillaceous earth of the shale, forms alum. About a hundred and twenty tons of calcined shale will make one ton of alum. The shale after being calcined is steeped in water, by which means the alum, which is formed during the calcination of the shale, is dissolved. This dissolved alum undergoes various operations before it is prepared for the shops. This kind of shale forms large strata in Derbyshire, and frequently above the coal, in most coal counties throughout the kingdom.

SHALLOP, a small light vessel, with two masts and lug sails. Being good sailers, they were formerly much used by smugglers, and are now generally employed as tenders upon ships of war.

Shallop, a sort of large boat with two masts, and usually rigged like a schooner.

SHAMBLE, in Mining, a sort of niche or landing place, left at certain distances for raising ore or rubbish with shovels, when the depth is too great for one cast to lift it to the surface. Shambles are sometimes formed of boards, and at other times of benches cut in the ground.

Shambles, in Marketing, are places where butchers expose their meat for sale in public.

SHAMMY, or Chamois Leather, a kind of leather, dressed either in oil or tanned; and much esteemed for its softness, pliancy, and being capable of bearing soap without hurt. The true shammy is prepared of the skin of the chamois-goat. *See* Capra. The true chamois leather is counterfeited with common goat, kid, and even sheep skin; the practice of which makes a particular profession, called by the French, chamoisure. The last is the least esteemed.

SHANK, among Sailors, implies the beam or shaft of an anchor. *Shank-Painter*, a short rope and chain which sustains the shanks and flukes of an anchor against the ship's side, as the stopper fastens the ring and stock to the cat-head.

SHANSCRIT, or Sanscrit, is the original language of the Hindoos, and is that in which their shaster, or holy book, is written.

SHARE, in Agriculture, that part of a plough which enters and breaks the ground.

SHARK, in Ichthyology, a large voracious fish. Of this fish there are several species, as the blue, the basking, and the hammer-headed shark. They chiefly reside in the seas of warm climates, but occasionally visit colder regions. Some have been known to weigh four thousand pounds, and men have been found whole in them when opened.

Shark *See* Squalus.

SHARP, in Music, a character, the power of which is to raise the note before which it is placed half a tone higher than it would be without such a preposition.

Sharp-*Bottom*, is synonymous with a sharp floor, and is used in contradistinction to a flat floor.

SHASTER, or Shastram, a sacred book containing the religion of the Banians; it consists of three tracts: the first of which contains their moral law; the second, the ceremonial; and the third delivers the peculiar observances for each tribe of Indians.

SHAWL, an article of female dress much prized in the East, and now commonly worn in Europe. Their prices vary, from one to 200 guineas, according to the fineness of their texture and materials, and the elegance with which they are finished.

SHEAF, a small bundle of corn in the ear, bound up in the field, for the accommodation of carriage and thrashing.

SHEARING, in Agriculture, the reaping of grain. Shearing also signifies the act of taking off the fleece from the sheep.

SHEARWATER, in Ornithology, a bird well known in the Orkney isles, and in several other places. The young birds are caught in abundance in August, and, salted in barrels, are preserved for winter provisions.

SHEATHING, in Naval Architecture, a sort of covering nailed all over the outside of a ship's bottom, to protect the planks from the pernicious effects of worms. This sheathing, in former years, consisted of thin boards, but sheets of copper having been found far preferable, these have of late been almost universally adopted, especially in long voyages. The corrosion, however, arising from the action of the salt water, being more rapid than was expected, several experiments have been made to counteract its influence. For the improvement of copper sheathing by an alloy, a patent was taken out by Mr. Robert Mushet, of the Royal Mint. His alloy consisted of two ounces of zinc, or four ounces of antimony, or eight ounces of arsenic, or two ounces of grain-tin, being added to one hundred pounds of copper. Another patent was taken out by Mr. Christopher Pope, of Bristol, for an invention which discarded copper altogether, and substituted plates composed of tin and zinc, or of tin, zinc, and lead united. These combinations, however, not fully answering general expectation, the lords of the Admiralty consulted Sir Humphrey Davy on the subject. This scientific gentleman, after a number of experiments, recommended the fixing of small masses or wires of tin, or of some other readily oxidable metal, in contact with the copper, by which he expected that the copper would be rendered so negatively electrical, that the sea water would act but slightly on it. In reducing theory to practice, his anticipations have not, however, been realized according to his wishes; and it is probable that copper sheathing must remain, as heretofore, until some more beneficial method shall appear, that has not yet been discovered.

SHEAVE, a cilindrical wheel of hard wood, fixed by a pin in a block, to form the pulley.

SHECHINAH, in Jewish history, the name of that miraculous light, or visible glory, which was a symbol of the divine presence.

SHED, in rural economy, a slight temporary building, to shelter cattle, or implements of husbandry, from the weather.

SHEEP, in Agriculture, a well-known and valuable animal, of which the breeds and varieties are numerous.

SHEEPSHANK, a sea term, implying a kind of knot made on a rope to shorten it, and is particularly used on runners or ties, to prevent the tackle from coming block and block. By this contrivance, the body to which the tackle is applied may be hoisted much higher, or removed much further in a shorter time. Thus, if any weighty body is to be hoisted into a ship, and it be found that the blocks of the tackle meet before the object reach the top of the side, it will be necessary to lower it again, or hang it by some other method, till the runner of the tackle is sheepshanked, by which the blocks will again be separated to a competent distance.

SHEER, the longitudinal curve of a ship's decks or sides. *Sheer* is also the position in which a ship is sometimes kept when at single anchor, in order to keep her clear of it; hence, *To break Sheer*, is to deviate from that position, and thereby risk the fouling of the anchor.

SHEERING, or Shearing, in Woollen Manufacture, is the cutting off with large shears the too long nap, in order to make the cloth more smooth and even.

Sheering, the act of deviating or straying from the line of the course, so as to form a crooked and irregular path through the water, and may be occasioned by the ship's being difficult to steer, but it more frequently arises from the negligence or incapacity of the helmsman. *To Sheer up alongside*, to approach a ship in a parallel direction. *To Sheer off*, to remove to a greater distance.

SHEERS, a nautical term, the name of an engine used to hoist in or get out the lower masts of a ship, and are either placed on the side of a quay or wharf, or are fixed on board of an old ship cut down; or, lastly, they are composed of two masts or large spars lashed together, and erected in the vessel wherein the mast is to be planted or displaced, the lower ends of the props resting on the opposite sides of the deck, and the upper parts being fastened together across, from which a tackle depends; this sort of sheers is secured by stays extending to the stem and stern of the vessel.

SHEET, a rope fastened to one or both the lower corners of a sail, to extend and retain it in a particular situation. When a ship sails with a side wind, the lower corners of the main and fore sails are fastened by a tack and a sheet, the former being to windward, and the latter to leeward; the tack is, however, only disused with a stern wind, whereas the sail is never spread without the assistance of one or both of the sheets; the staysails and studding-sails have only one tack and one sheet each; the staysail tacks are fastened forward and the sheets drawn aft, but the studding-sail tacks draw the outer corner of the sail to the extremity of the boom, while the sheet is employed to extend the inner corner: hence, *To Sheet home*, is to haul home a sheet, or to extend the sail till the clue is close to the sheet-block.

SHEKEL, in Jewish Antiquity, an ancient coin, worth 2s. 3¼d. sterling.

SHELF, among Miners, the same with what they otherwise call fast ground, or fast country; being that part of the internal structure of the earth, which they find lying even and in an orderly manner.

SHELL, in Artillery. See the article Bomb, &c. *Shell of a Block*, the outer frame, or case, wherein the sheave or wheel is contained, and traverses about its axis.

Shells. Marine shells may be divided, as Mr. Hatchet observes, into two kinds: those that have a porcelainous aspect with an enamelled surface, and when broken are often in a slight degree of a fibrous texture; and those that have generally, if not always, a strong epidermis, under which is the shell, principally or entirely composed of the substance called nacre, or mother-of-pearl. The porcelainous shells appear to consist of carbonate of lime, cemented by a very small portion of animal gluten. This animal gluten is more abundant in some, however, as in the patallæ. The mother-of-pearl shells are composed of the same substance. They differ, however, in their structure, which is lamellar, the gluten, forming their membranes, regularly alternating with strata of carbonate of lime. In these two the gluten is much more abundant.

SHEPHERD, one who has the care and management of sheep.

SHERIFF. As keeper of the king's peace, the sheriff is the first man in the county, and superior in rank to any nobleman therein, during his office. He may apprehend and commit to prison all persons who break the peace, or attempt to break it, and may bind any one in a recognizance to keep the king's peace.

SHIELD, an ancient weapon of defence, in the form of a light buckler, borne on the arm, to turn off lances, darts, &c.

**SHIFTED**, the state of a ship's ballast or cargo when it is shaken from one side to the other, either by the violence of her rolling, or by her too great inclination to one side under a great pressure of sail; this accident, however, rarely happens, unless the cargo is stowed in bulk, as corn, salt, &c.

**SHIFTER**, a person appointed to assist the ship's cook in washing, steeping, and shifting the salt provisions.

**SHILLER Stone**, a mineral nearly allied to serpentine.

**SHILLING**, an English silver coin, equal to twelve pence, or the twentieth part of a pound.

**SHIM**, in Agriculture, a tool used in breaking down and reducing the more stiff and heavy sorts of land, as well as cutting up and clearing them from weeds.

**SHINGLE**, in Agriculture, the thinnings of fir and other timber trees, which are much used in making fences, &c.

**Shingle**, *Rubbish*, found on the sea shore, and used for ballasting ships, protecting embankments, and preventing the encroachments of the sea.

**Shingles**, in Building, small pieces of wood, chiefly oak, used for covering roofs, where other materials are scarce, and something light is required.

**SHIP**, a general name given to all vessels navigated on the ocean; in the sea language, however, it is more particularly applied to a vessel furnished with three masts, each of which is composed of a lower-mast, a top-mast, and top-gallant-mast, with the yards and other machinery thereto belonging. *A Ship cut down*, implies one which has had a deck cut off from her, whereby a three-decker is converted into a two-decker, and a two-decker becomes a frigate. *A Ship raised upon*, is one whose dead works have been heightened by additional timbers.

*Hospital* **Ship**, a vessel fitted up to attend a fleet of men-of-war, and receive their sick or wounded, for which purpose her decks are high, and her ports large. The gun-deck is entirely appropriated for the reception of the sick, and is flush without cabins or bulk-heads, except one of deal or canvass, for separating those in malignant distempers. Two pair of checquered linen sheets are allowed to each bed, and scuttles cut in the sides for inlets of air. The sick are visited by a physician, and constantly attended by a surgeon, a proportional number of mates, assistants, baker, and washerwomen. Her cables ought also to run upon the upper deck to the end, that the beds or cradles may be more commodiously placed between decks, and admit a free passage of the air, to disperse that which is offensive or corrupted.

*Merchant* **Ship**, a vessel employed in commerce to carry commodities of various sorts from one port to another, the largest of which are those used in trading to the East Indies. *Prison Ship*, a vessel fitted up to receive prisoners in a port. *Private Ship of War*. See Privateer. *Receiving Ship*, a ship stationed at any place to receive volunteers and impressed men, and train them to their duty in readiness for any ship of war which may want hands. *Slave Ship*, a vessel employed in carrying negro slaves from the coast of Africa to the West Indies, &c. whence she returns to Europe with a cargo of rum, sugar, coffee, cotton, &c. *Slop Ship*, a vessel appointed as a depôt of clothes for the seamen. *Store Ship*, a vessel employed to carry artillery and stores for the use of a fleet, fortress, or garrison. *Troop Ship*, is one appointed to carry troops, and is frequently termed a transport.

**Ship** *Building*, may be defined, the manner of constructing ships, or the work itself, as distinguished from naval architecture, which may be considered as the theory or art of delineating ships on a plane.

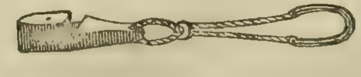
**SHIPWRECKED Seamen**, *Plan for the Preservation of, by Captain G. W. Manby.—Instructions.* After the means of communication have been effected between a stranded vessel and the shore, by a rope attached to a shot projected from a mortar, it is often found a matter of great difficulty to make the persons on board know how they are to act, and many lives have been lost through this cause alone. In order to remedy this evil; and to render this system of relief mutually and immediately understood, the following instructions are submitted:—

*Directions to Persons on board Vessels stranded on a Lee-Shore.*—It is your duty, as well, no doubt, as your inclination, to use every honourable and manly endeavour to save the vessel and cargo committed to your care, and to satisfy yourself that these have failed, before it is a justifiable resource to run the ship on shore, for the preservation of your own lives. On the determination being made to run for the beach, every exertion should be made to keep your vessel off the shore till high water, and then, if canvass is or can be set, steer the vessel stem on with as much force as possible, making signals of distress to attract the notice of the people on shore, who will collect at the point most favourable for the purpose, and prepare to assist you; endeavour to run for the spot where they are collected. Shipmasters, on these occasions, must enforce their authority more than ever, and seamen must be more than usually obedient, as the safety of all on board will frequently depend on this.

Whether a vessel is thus run on shore, or is stranded, without any choice of time or place, the following directions will equally apply, and must be minutely observed and practised:—Collect, in some safe part of the vessel, ready to apply as occasion may require, all your small lines and ropes, buoys, pieces of cork, or small kegs, (such as seamen keep spirits in,) snatch, tail, and other blocks, with a warp or hawser clear, axes, knives, &c.: all these may be of great use. Attend to the people on shore, and observe if they have a boat, or are getting one to the spot, as their first object would be to launch it to you, and to throw a line on board you, to haul her off with; in that case they will make signal No. 1. The signals, illustrated by representations and their distinct meanings, will be hereafter described. On receiving the line, you will secure the end to such part of the vessel as may best draw the boat into a safe lee. If the people on shore, after you have received the line, make signal No. 2, you will bend the warp or hawser to the line, and they will draw it on shore, fearing to trust the boat to the small line. When the bend is made, and you are ready, make your signal No. 1, (which will be hereafter described, expressing *yes*.) If, when you have got the line, the people on shore find you have not a warp ready, and wish you to haul on board by it a stouter rope to haul the boat off with, they will make signal No. 3, to haul away, for you to receive a stout rope; secure it as before directed, and make your signal No. 1, which is also to denote *you are ready*, or their direction is complied with.

*Remark.*—A boat, when it can be applied, is the promptest method of bringing a crew on shore. Upwards of twenty crews have been saved by them.

If, when you have received the line, and observe there is no boat at hand, and the signal on shore (No. 3) is made, you will haul in, and receive by it the end of a stout rope, and a tail-block rove with a small line, both ends of which are kept on shore; make the end of the stout rope and the tail of the block well fast round your mast, higher or lower, as circumstances require, and the tail-block close below the large rope. On your making signal No. 1, denoting to have complied with the direction of having carefully secured the stout rope and tail-block, the people on shore will haul taut the stout rope, and place on it a snatch-block, (with a sling hanging to it large enough to hold a man;) and making the ends of the small line fast to the lower part of the snatch-block, they will work it to the ship, when, on a man getting into the sling, he will, by pulling down the slide or button, secure himself in, and safely lashing himself by the waist to the upper part of the sling, prevent the possibility of falling out; and on seeing the clasp*



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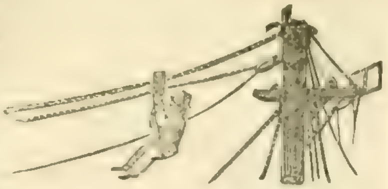
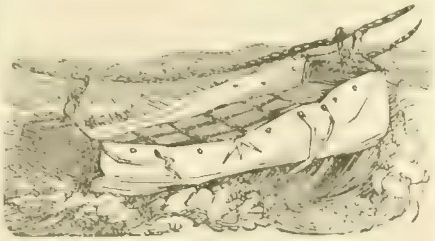
* This remark is necessary, from the omission of the clasp being here represented, that should cross the mouth of the block.

of the block forelocked, make signal (No. 1), that all is ready, the people on shore will haul the man to the land, and in the same manner will travel the snatch-block back, until every person is got from the wreck, as here represented.

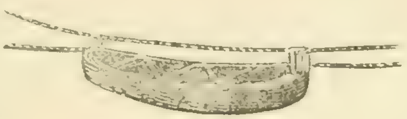


*Remark.* Crews have thus been brought in safety from distances exceeding 240 yards from the shore, and also from wrecks to the top of a cliff.

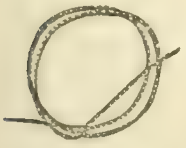
If the vessel stranded have women, children, sick or infirm persons on board, who could not go aloft, instead of a snatch-block and sling, a cot, with lashings, to prevent persons being washed out, may be worked in the manner just described.

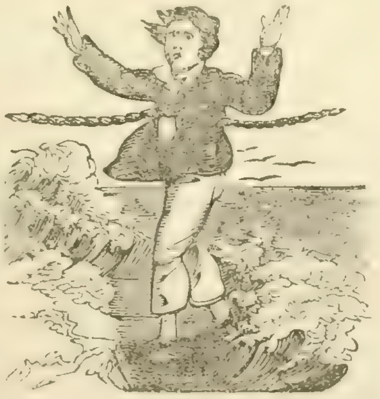


If the stranded vessel is driven among the rocks, and the persons in danger of being killed, or severely wounded from the surf dashing them with force against the rocky beach, a hammock stuffed with cork parings or shavings, as here represented, would protect them from injury.



If the people on shore have only the means of projecting a line for your preservation, they will make signal No. 4, for you to secure it, and draw on board so much as will fully reach from the vessel to the shore, to ensure a continued communication; with it make a clove hitch, which is to be put over the shoulders and arms of those to be brought on shore, and draw it tight, in manner here represented; and on your making signal (No. 1,) that you are ready, take care to clear the wreck, and jump overboard, when the people on shore will instantly haul you through the surf in safety.

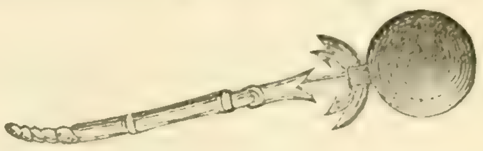




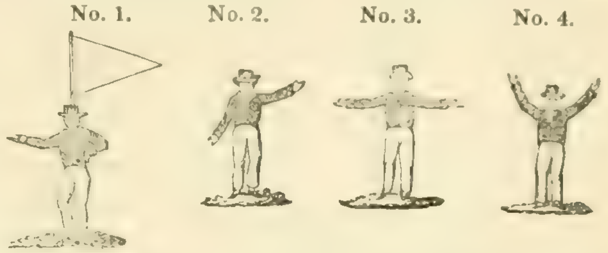
*Remark.* Upwards of 50 persons have been saved in this manner, and among them one woman. Should females or persons on board, from fear or agitation, be deprived of confidence in this mode of relief, a cushion, stuffed with fine cork parings, in the form represented, with lashings, so as to be easily adjusted to the body, would make a floating belt, in this manner, and effectually prevent the wearer from all danger or possibility of drowning.

*Remark.* How important it would be to the preservation of life from shipwreck, if every owner of a vessel would consider it a duty he owes to humanity, to cause a hammock, and cushions, stuffed as described, to be kept on board his ship. The expense would be a mere trifle, as cork shavings or parings are considered of little or no value, they would also be eminently useful in preventing a boat from sinking, by placing them under the thwarts.

If the distance from the shore is too great for the mortar to be tried, or if the shot falls short of the vessel, bend your lightest and best-stretched line to the buoy, veer it away gently, not paying out too fast; buoy up your line every twenty fathoms, if you can, with corks or small spirit kegs, or any thing you may have fit for the purpose; the buoy will not reach the shore, but it will drive near enough to enable them to throw a grapnell shot over it, to draw it on shore: when this is done, look out for the signals as before, and be prepared in every way to obey them, and to act with the people on shore.



*Form of Signals from the Shore.*—The signal man will stand clear of the crowd, and place himself in front of a small flag. No. 1. Are you ready—or look out for the rope; we are preparing to launch a boat to you. No. 2. Secure the rope; bend a warp or hawser to it, for us to draw it on shore for the boat—or for us to send you a stout rope, to be made fast to some firm parts of the wreck, for us to haul off a boat. No. 3. Haul away—to receive a stout rope, snatch-block with sling, cot, or hammock. No. 4. Haul on board enough of the line to ensure a continued communication—take care to clear the wreck.


No. 1.
No. 2.
No. 3.
No. 4.

*Signals to be made from the Ship, in Reply to any Directions.*—No. 1. A man, in some conspicuous situation, will wave his arm three times horizontally, or across him, to denote *yes*, or *ready*. If he has a hat, let him take it in the hand he waves. No. 2. Three times up and down, to answer *no*, or *not ready*.

*Trengrouse's Life Preserver.*—Another contrivance for the preservation of lives in cases of shipwreck, has been invented by a Mr. Henry Trengrouse of Helstone, in Cornwall. In some respects it bears a resemblance to that of Captain Manby, but in others it is so essentially different, that a general outline of his plan merits an insertion in this work.

"To render any contrivance," he observes, "for the saving of lives in case of a wreck, extensively or generally useful, both reason and experience have convinced me that the apparatus must be kept on board. I therefore feel great satisfaction in reflecting on the success that has at last attended my labours, in devising the means to open the communication; my methods being such as induce me to believe they are not to be equalled by any other which is not on the same principle. I have not tried how far I can project a line, but I have no doubt of being able to do it with all necessary precision upwards of half a mile. With the other parts of the apparatus I am also fully satisfied. With their simplicity and portability are combined accommodation and security, and the whole may be used with all possible expedition.

Mr. Trengrouse, it seems, was led into a train of reflections which have terminated in this happy result, by the loss of the Anson frigate, which was wrecked near the Loe Bar, not far from Helston, the place of his residence; in which ship about one hundred individuals, including the commander, perished. His first attempt was simply to fasten the end of the line to a piece of lead, and then to throw it on shore: but this he soon found could only be serviceable when the vessel lay contiguous to the land. His second scheme was that of hoisting a kite, and permitting it to hang over the land, and then causing it to fall where the people on the beach or rocks might seize it, and draw a line on shore. In this he at first placed much confidence; but after some time he saw reason to abandon it, as being too uncertain to justify dependence. His third method was that of a rocket, which he says has answered his most sanguine expectation. A line being thus thrown on shore by means of the rocket, and drawn by the people on the land, can soon bring from the wreck a rope, which, being made fast, and drawn as tensely as possible, will enable those on board to put his life-preserver into immediate use.

"A model of the Preserver," he observes, "and a written description of it, I shewed to a gentleman in this neighbourhood, who consulting with a friend of his who had formerly belonged to the Admiralty, was led with his friend to conclude that the invention was entitled to consideration. The former gentleman then caused it to be transmitted to Government, after which I heard no more about it. Probably the bustle created by the war in the naval department, and my not having made a single experiment with any part of the apparatus, to ascertain its practicability, as a recommendation for its adoption, might have been two reasons why it was not attended to. Several months had now elapsed without my hearing any thing about it, or making any experiments. But my feelings were as much alive as ever to the object I had in view; and although I did not succeed in my first efforts, I proceeded under the unaltered conviction that the principle was good, and that if the apparatus should become a portable part of the ship's equipment, in case of a wreck many lives might be preserved. To ascertain the most effectual means for accomplishing this desirable object, I tried many experiments; but though in some cases the use of a musket might answer every purpose, I finally gave the preference to the rocket. With these, after making numerous attempts, I have so far succeeded, as to believe, that there is not another man in the united kingdom who can project a line to an equal distance, and with equal precision and promptitude, with any description of apparatus equal in portability, which is not on the same principle. The line which I project is adequate to draw a rope on shore sufficiently large to be used as a hauling-rope to draw persons through the water, or above the water on a hawser. If through the water, then a float is to be affixed on the rope, which may be done in a minute, and wrapped round the body of the person to be floated to land; when, committing himself to the water, he will be instantly drawn to the shore. On being thus saved, the float must again be hauled to the wreck for the next person; and thus continue to pass and repass until all are secured. But if the stranded vessel should not go immediately to pieces, a hawser may be carried from the wreck and made fast on shore. This being drawn tight, all on board may be landed comfortably and quickly, by means of a *chaise rolante*, suspended on wheels that are curiously contrived to run upon the hawser. They are so constructed that they may be worked with the utmost rapidity, without producing any observable friction. The chaise rolante is a safe, easy, and comfortable conveyance; it affords the accommodation of an arm-chair, and is perfectly secure for the infirm, the sick, or wounded, and also for women and children. It is so portable, that a child of three years of age may carry it under his arm. With these parts of the apparatus, I made my first experiments at Porthleaven in 1816. This was the first time that the float was ever in the water, and that the chaise rolante was ever suspended to a rope. A great number of spectators was present; among whom were several respectable gentlemen; to whom general satisfaction was given." Of this experiment the following account was afterwards published by a Mr. Russell, who was a spectator of what he here relates. "On Friday last, Mr. Trengrouse publicly exhibited the use of his apparatus at Porthleaven. From the western shore he threw several lines across the harbour, which went over the pier to some distance on the outer side. The length of line projected was about 200 yards. He has so perfected this part of his plan, as certainly to render it superior to every other method. A float made of cork was applied to the body of a man with his clothes on, who volunteered his services though the wind blew hard. He was soon hauled across the harbour in a buoyant state. The advantages of this float must be obvious to any one, who has ever witnessed the manner in which shipwrecked mariners are dragged through the foaming surf, from their perishing vessel to the shore. They are almost killed, that their lives may be saved. The same man who had thus been drawn across the harbour in the float, soon made a signal to return by the same route. He accordingly took his seat in the chaise rolante, suspended to a large rope, which had been drawn across the harbour. In this he was conveyed over, and back again, in little more than two minutes."

After this first attempt, Mr. Trengrouse made several experiments before many scientific gentlemen, high in rank, both in the naval and military department, to whom his invention gave the fullest satisfaction. These have attested their approbation by their signatures, and the importance of his life-preserver has been so far appreciated as to procure for the inventor a diamond ring from the emperor of Russia.

SHOAD, in Mining, stones containing ore mixed with rubbish in a loose soil, and sometimes near the surface. When deep, the miners consider it as indicating that some vein is at no great distance.

SHOAL, a term synonymous with shallow.

SHOAR, a prop or stanchion fixed for support against a wall, or under a ship's sides or bottom, to support her when laid aground, or on the stocks, &c.

SHOE, a covering for the foot, usually made of leather.

Shoe *of the Anchor*, a small block of wood, convex on the back, and having a hole sufficiently large to contain the point of the anchor-fluke on the fore side; it is used to prevent the anchor from tearing the planks on the ship's bow, when ascending or descending; for which purpose the shoe slides up and down along the bow, between the fluke of the anchor and the planks, as being pressed close to the latter by the weight of the former. *To Shoe an Anchor*, is to cover the flukes with a broad triangular piece of thick plank, whose area is greater than that of the flukes. Its use is to give the anchor a stronger and surer hold in very soft or oozy ground.

Shoeing *of Horses*, a term applied to the operation of fastening pieces of iron on the bottom parts of the hoofs, or that of nailing the shoes to their feet. This is an employment which requires much care, that the hoofs may not be injured, and that the animal may not be made lame.

SHOOT, in Agriculture and Gardening, the young branch of any sort of plant, which is produced in one season.

SHOPLIFTER, one who, under the pretence of purchasing goods in a shop, takes an opportunity to steal them. If the amount stolen be above five shillings, the thief is guilty of felony, without benefit of clergy, by 10 and 11 W. III. c. 22.

SHORE, in Agriculture, a sort of artificial drain, formed in low flat lands, for relieving them from the waters collected on their surface.

Shore; the general name for the sea-coast of any country. *Bold Shore*, a coast which is steep and abrupt, so as to admit the near appoach of shipping, without exposing them to the danger of being stranded; and is used in contradistinction to a shelving shore.

SHOT, a missive weapon, discharged by the force of ignited powder from a fire-arm in battle; of these there are various kinds, as, *Round Shot*, or *Bullets*, a ball or globe of iron, whose weight is in proportion to the bore of the cannon. *Double-headed*, or *Bar Shot*, are formed of a bar with a round head at each end, which fits the muzzle of the cannon. The middle is sometimes filled with a composition, and the whole covered with linen dipped in brimstone; so that the cannon, in firing, inflames the combustibles or composition of this ball, which sets fire to the sails of the enemy. One of the heads of this ball has a hole to receive a fuse, which communicating with the charge of the cannon, sets fire to the bullet. *Chain Shot*, consist of two balls chained together, being principally designed to annoy the enemy by cutting her sails, rigging, &c. *Grape Shot*, is a combination of balls strongly corded in canvass upon an iron bottom, so as to form a sort of cylinder, whose diameter is equal to that of the ball which is adapted to the cannon. *Case Shot*, or *Cannister Shot*, are composed of a great number of small bullets, put into a cylindrical tin box. They are principally used when very near, to clear the decks of the enemy. Besides these, there are others of a more pernicious kind, used by privateers, pirates, &c. such are langrage shot, star shot, fire-arrows, &c. Star shot consists of four pieces of iron, whose bases, when separate, form the quadrant of a circle; so that the whole being joined, forms a cylinder equal to the shot of the cannon. Each of these pieces is furnished with an iron bar, the extremity of which is attached to a sort of link, as keys are strung upon a ring. Being discharged from the gun, the four branches or arms extend every way from the link in the centre. These also are chiefly intended to destroy the sails or rigging; but their flight and execution are very precarious at any tolerable distance.

SHOVEL, in Agriculture, a well-known implement, with a long handle and wide blade, used instead of a spade, and by some labourers preferred to it. Shovels are differently formed, according to the purpose for which they are applied.

SHOWER, a cloud resolved into rain, and discharged during a limited period on a certain tract of ground.

SHRIMP, in Natural History, is the cancer crangan of Linnæus. This shell-fish inhabits the sandy shores of Great Britain in vast quantities, and is reckoned a great delicacy. In form, the shrimp nearly resembles the lobster.

SHRINE, in Ecclesiastical History, a case or box to hold the relics of some saint.

SHROUDS, a range of large ropes extended from the mastheads to the right and left sides of a ship, to support the masts, and enable them to carry sail, &c. The shrouds are always divided into pairs or couples, that is to say, one piece of rope is doubled, and the parts fastened together at a small distance from the middle, so as to leave a sort of noose or collar to fix upon the mast-head; the ends which reach to the deck have each a dead-eye turned in or fastened to them, by which they are extended to the channel. The shrouds, as well as the sails, &c. are denominated from the masts to which they belong; thus there are the main, fore, and mizzen shrouds; the main-top-mast, fore-top-mast, and mizzen-top-mast shrouds; and the main-top-gallant, fore-top-gallant, and mizzen-top-gallant shrouds. *The Top-mast Shrouds* are extended from the top-mast head to the edges of the tops by the foot-hook plates. See the article Plate. The upper ends of the futtock-shrouds are furnished with iron hooks, which enter holes in the lower ends of the foot-hook plates, so that when the top-mast shrouds are set up or extended, the futtock shrouds require an equal tension. *The Top-gallant Shrouds* are extended to the cross-trees, where passing through holes in their ends, they continue over the futtock-staves of the top-mast rigging, and descending almost to the top, are set up by laniards passing through thimbles instead of dead-eyes. *Futtock* or *Foot-hook Shrouds* are pieces of rope communicating with the futtock-plates above and the catharpings below, and forming ladders whereby the sailors climb up to the top-brim. *Bowsprit Shrouds* are shrouds put over the head of the bowsprit, and extended on each side to the ship's bows, to support the former. *Bumkin Shrouds* are strong ropes, fixed as stays or supports to the bumkin ends, to prevent their rising by the efforts of the fore-tacks upon them. *Bentick Shrouds* are strong ropes fixed on the futtock-staves of the lower rigging, and extending to the opposite channels, where they are set up by means of dead-eyes and laniards, in the same manner as the other shrouds; their use is to relieve or support the masts when the ship rolls.

Shroud, a shelter or cover, is used to denote the dress of the dead. If any person, in taking up the dead body, steals the shroud, the property of which remains in the executor, or the person who was at the charge of the funeral, it is felony.

SHROVETIDE, the time immediately before Lent, and thus called by our ancestors, because employed in *shriving*, that is, in confessing their sins to the priest, in order to a more devout keeping of the ensuing Lent fast. *Shrove Tuesday*, is the day next before the beginning of Lent.

SHROWDING of Trees, is the cutting or lopping off the top branches of such trees as are not fit for timber. Ash trees of this kind are sometimes called pollards.

SHRUBS, in Botany and Vegetable Physiology, are commonly understood to be plants with a perennial woody stem, of a more humble and slender form of growth than those denominated trees.

SHRUBBERY, a portion of ground planted with shrubs, trees, and flower plants, for the purpose of ornament.

SHUCK, or Shock, in Agriculture, ten or twelve sheaves of corn placed together in an erect position, in a harvest field, with the corn upwards. It is sometimes called *stoak*.

SHUME, or Asshume, an exceedingly hot wind of Africa, which, in the intermediate journeys between several parts of the great desert, or Sahara, occasions great inconvenience and distress to travellers. It sometimes wholly exhales the water carried in skins by the camels for the use of the travelling party; and instances have occurred, when five hundred dollars have been offered for a draught of water. From ten to twenty is a common price when a partial exhalation has taken place. In 1805, a caravan proceeding from Timbuctoo to Tafilet, was disappointed at finding no water at one of the usual watering places; and such was the calamity, that it is said all the persons belonging to it, 2000 in number, and 1800 camels, perished by thirst.

SHUTTLE, in the Manufactures, an instrument much used by weavers, in the middle or near the end of which is an eye or cavity wherein is enclosed the spoul with the woof.

SHWAN Pan, the name of a Chinese instrument, which they use to assist them in their computations. It is composed of wires with beads upon them, which they move backwards or forwards, as occasion requires. *See* Abacus.

SIALAGOGUES, in Medicine, the name of all such simples or compounds as increase the flow of saliva.

SIBERS, an infectious disease of a chronic nature, somewhat resembling the syphilis, prevalent in the western parts of Scotland. It is said to be so denominated, from the appearance of a fungous exuberance from some of the cutaneous sores, not unlike a raspberry; the word *sibben*, or *sivven*, being the Highland appellation for a wild raspberry. This disease is not of ancient date in Scotland.

SIBSIT, in Zöology, an animal of the empire of Morocco, abounding in the mountains of Suse, of an intermediate species between the cat and the squirrel.

SIBYLS, ancient virgin prophetesses, whose fame has been spread throughout the world. Their books were held sacred in Rome, but were destroyed when the capitol was burnt, eighty-five years before Christ. Other copies were afterwards collected, but they are acknowledged to be imperfect, if not altogether fabulous.

SICARII, in ancient history, assassins of Judea, who went about the country committing depredations, with short swords concealed under their garments. Josephus has described them in the most odious colours.

SICE-ACE, a game with dice, and tables, whereat five may play, each having six men; and the last out, losing. At this game they load one another with aces; sixes bear away; and doublets drinks, and throws again.

SICERA, the Hellenist Jews give this name to any intoxicating liquor. Some have thought that it meant nothing but palm wine.

SICKLE, in Agriculture, a toothed-hook used in reaping corn. There are great varieties in their construction.

SICUB, a species of hawk, about the common size, well known in the Philippine islands. Its plumage is elegantly variegated with yellow, white, and black.

SIDDOW, a peculiar kind of peas that boil freely. It is well known in some districts in Gloucestershire.

SIDEREAL DAY, is the time in which any star appears to revolve from the meridian to the meridian again; which is 23 hours 56′ 4″6 of mean solar time; there being 366 sidereal days in a year, or in the time of 365 diurnal revolutions of the earth.

SIDERATION, the blasting or blighting of trees, plants, &c. by eastern winds, excessive heat, continued drought, and similar causes.

SIDERITES a name which some authors give to the loadstone.

SIDERITIS, a plant, supposed to be efficacious for stanching of blood and healing of wounds, if newly made.

SIDEROMANTIA, an ancient kind of divination by laying straws upon red-hot iron. By observing their figures, bend-ings, sparkling, and burning, the imaginary prognostics were obtained.

**SIDES-MEN**, or Synod's Men, persons who in large parishes are appointed to assist the churchwardens in their inquiry and presentments of such offenders to the ordinary, as are punishable in the spiritual court.

**SIEGE**, in the art of war, the encampment of an army before a fortified place, with a design to take it.

**SIENITE**, a stone composed of felspar and hornblende, and sometimes quartz and black mica. The transitions by which granite passes into sienite, and the latter into porphyry, trap, and basalt, are gradual, and in some rocks almost imperceptible. These changes are principally effected by an intermixture of the mineral already described under the name of Hornblende.

**SIERRA**, is a word used for hill in various parts of the world, particularly on the west coast of Africa, on the north coast of South America, and on the coasts of Chili and Peru on the South Pacific ocean.

**SIERRILLO**, the term for a little hill, being a diminutive from Sierra; in which sense it is used on the south-west coast of South America also.

**SIEVE**, or Seave, an instrument serving to separate the fine from the coarse parts of powders, liquors, &c. and to cleanse pulse and corn from dust, light grain, &c.

**SIGAH Gush**, in Zöology, the name of a Persian animal of the cat kind, and no way differing from the lynx, only that it has no spots.

**SIGHING**, an effort of nature, by which the lungs are put into quicker motion, and become more dilated, so that the blood passes more freely, and in greater quantity, to the left auricle, and thence to the ventricle.

**SIGHT.** *See* Eye.

**SIGHTS of a Quadrant**, &c. thin pieces of brass raised perpendicularly on its side, or on the index of a theodolite, circumferentor, &c.

**SIGN**, in Astronomy, a constellation containing a twelfth part of the zodiac, or thirty degrees.

**SIGNALS**, certain notices used to communicate intelligence to distant objects. At sea they are made by firing artillery, displaying flags and pendants, lanterns or fire-works, as rockets and false-fires, and these are combined by multiplication and repetition; by which combination of signals, previously known, the admiral conveys orders to his fleet, every squadron, every division, and ship, of which, has its particular signal. Every ship to which a signal is made, immediately answers it by hoisting some particular flag, to shew that she has received and understands the order thereby conveyed. All signals may be reduced into three different kinds, viz. those which are made by the sound of particular instruments, as the trumpet, horn, or fife; to which may be added, striking the bell, or beating the drum. Those which are made by displaying pendants, ensigns, and flags of different colours; or by lowering or altering the position of sails; and, lastly, those which are executed by rockets of different kinds, by firing cannon or small arms, by artificial fire-works, and by lanterns. All signals, to be effectual, must be simple, and composed in such a manner as to express the same signification at whatever mast-head or yard-arm they may be displayed from. They should be issued without precipitation, exposed in a conspicuous place, so as to be seen at a distance, and sufficient time should be allowed to observe and obey them. Signals are very numerous and important, being all appointed and determined by order of the lord high admiral, or lords of the admiralty, and communicated in the instructions sent to the commander of every ship of the fleet or squadron, before their putting out to sea. Few subjects have more seriously engaged the attention of nautical men than that of signals; the labour, however, and study that has hitherto been expended on them, appear, even in the opinion of the inventors themselves, not to have been completely productive of that precision and correctness in conveying orders which is certainly the grand desideratum. The object is undoubtedly of the first consequence to a maritime power; the greatest inconveniencies have at different times arisen, as well in action as on other occasions, from the imperfect state of the code, and consequently every attempt to improve its effects, and diminish its imperfections, is truly laudable and worthy of consideration. The firing of great guns is common in the day night, or in a fog, to make or confirm signals; yet it must be confessed, that too great a repetition is apt to introduce mistakes and confusion, as well as to discover the track of the squadron. The report and flight of the rockets is liable to the same objection, when at a short distance from the enemy.

*Signals by Day.*—When the commander-in-chief would have them prepare for sailing, he first loosens his fore-top-sail, and then the whole fleet are to do the same. When he would have them unmoor, he loosens his main-top-sail and fires a gun, which in the royal navy is to be answered by every flag-ship. When he would have them weigh, he loosens his fore-top-sail and fires a gun, and sometimes hauls home his sheets; the gun is to be answered by every flag-ship, and every ship to get to sail as soon as she can. If with the leeward side, the sternmost ship is to weigh first. When he would have the weathermost and headmost ships to tack first, he hoists the union-flag at the fore-top-mast head, and fires a gun, which each flag-ship answers; but if he would have the sternmost and leewardmost ships tack first, he hoists the union-flag at the mizzen-top-mast head, and fires a gun; and when he would have all the whole fleet tack, he hoists an union, both on the fore and mizzen-top-mast heads, and fires a gun. When, in bad weather, he would have them wear and bring to the other tack, he hoists a pendant on the ensign-staff and fires a gun, and then the leewardmost and sternmost ships are to wear first and bring on the other tack, and lie by, or go on with an easy sail till he comes ahead: every flag is to answer with the same signal. If they are lying or sailing by a wind, and the admiral would have them bear up and sail before the wind, he hoists his ensign and fires a gun, which the flags are to answer; and then the leewardmost ships are to bear up first, and to give room for the weathermost to wear, and sail before the wind with an easy sail, till the admiral comes ahead. But if it should happen, when the admiral has occasion to wear, and sail upon the wind, that both jack and ensign be abroad, he will haul down the jack before he fires the gun, to wear and keep it down till the fleet is before the wind. When they are sailing before the wind, and he would have them bring to, with the starboard tacks aboard, he hoists a red flag at the flag-staff, on the mizzen-top-mast head, and fires a gun. But if they are to bring to with the larboard tack, he hoists a blue flag at the same place, and fires a gun, and every ship is to answer the gun. When any ship discovers land, he is to hoist his jack and ensign, and keep it abroad till the admiral or commander-in-chief answers him by hoisting his; on sight of which he is to haul down his ensign. If any discover danger, he is to tack and bear up from it, and to hang his jack abroad from the main-top-mast cross-trees, and fire two guns; but if he should strike or stick fast, then, besides the same signal with his jack, he is to keep firing till he sees all the fleet observe him, and avoid the danger. When any sees a ship or ships more than the fleet, he is to put abroad his ensign, and there keep it, till the admiral's is out, and then to lower it, as often as he sees ships, and stand in with them, that so the admiral may know which way they are, and how many; but if he be at such a distance that the ensign cannot well be discovered, he is then to lay his head towards the ship or ships so descried, and to brail up his lower sails, and continue hoisting and lowering his top-sails, and making a waft with his top-gallant-sails, till he is perceived by the admiral. When the admiral would have the vice-admiral, or him that commands in the second post of the fleet, to send out ships to chase, he hoists a flag, striped white and red, on the flag-staff, at the fore-top-mast head, and fires a gun. But if he would have the rear admiral do so, he then hoists the same signal on the flag-staff at the mizzen-top-mast head, and fires a gun. When the admiral would have any ship to chase to windward, he makes a signal for speaking with the captain, and he hoists a red flag in the mizzen-shrouds, and fires a gun; but, if to chase to leeward, a blue flag; and the same signal is made by the flag in whose division the ship is. When he would have them give over the chase, he hoists a white flag on the flag-staff at the fore-top-mast head, and fires a gun; which signal is to be made also by that flag-ship which is nearest the ship that gives the chase, till the chasing ship sees the signal. In case of springing a leak, or any other disaster that disables their ship from keeping company, they are to haul up their courses, and fire two guns. When any ship would speak with the admiral, he must spread an English ensign from the head of his main and fore-top-mast downwards on the shrouds, lowering his main or fore-top-sail, and firing guns till the admiral observes him; and if any ship perceive this, and judge the admiral does not, that ship must make the same signal to acquaint the admiral therewith, who will answer by firing one gun. When the admiral would have the fleet to prepare to anchor, he hoists an ensign, striped red, blue, and white, on the ensign-staff, and fires a gun, and every flag-ship makes the same signal. If he would have the fleet moor, he hoists his mizzen-top-sail with the clue lines hauled up, and fires a gun. If he would have the fleet cut or slip, he loosens both his top-sails, and fires two guns; and then the leeward ships are to cut or slip first, to give room to the weathermost to come to sail. So, if he would have any particular ship to cut or slip, and to chase to windward, he makes the signal for speaking with that ship, hoists a red flag in the mizzen-shrouds, and fires a gun; but if the ship is to chase to leeward, he hoists a blue flag as before. If he would have the fleet exercise their small arms, he hoists a red flag on the ensign-staff, and fires a gun; but if the great guns, then he puts up a pendant over the red flag.

*Signals by Night.*—Night signals should be used as little as possible, since they are frequently misunderstood. Of necessity, they must be composed of either sound or light, or the two blended together. Those to be observed at an anchor, weighing anchor, and sailing, are as follow: when the admiral would have the fleet to unmoor and ride short, he hangs out three lights, one over another, in the main-top-mast shrouds, over the constant light in the main-top, and fires two guns, which are to be answered by flag-ships; and each private ship hangs out a light in the mizzen-shrouds. *N. B.* All guns, fired for signals in the night, must be fired on the same side, that they may make no alteration in the sound.—When he would have them weigh, he hangs a light in the main-top-mast shrouds, and fires a gun, which is to be answered by all the flags, and every private ship must hang out a light in her mizzen-shroud. When he would have them tack, he hoists two flags on the ensign-staff, one over another, above the constant light in his poop, and fires a gun, which is to be answered by all the flags; and every private ship is to hang out a light extraordinary, which is not to be taken in till the admiral takes in his. After the signal is made, the leewardmost and sternmost ships must tack as fast as they can, and the sternmost flag-ship, after she is about on the other tack, is to lead the fleet, and her they are to follow, to avoid running foul of one another in the dark. When he is upon a wind, and would have the fleet veer and bring to on the other tack, he hoists up one light on the mizzen-tack, and fires three guns, which is to be answered by the flag-ships, and then every private ship must answer with one light at the mizzen-peek. The sternmost and leewardmost ships are to bear up as soon as the signal is made. When he would have them in blowing weather to lie by, short, or a-hull, or with the head-sails braced to the mast, he will form lights of equal height, and fire five guns, which are to be answered by the flag-ships, and then every private ship must shew four lights; and after this, if he would have them make sail, he then fires ten guns, which are to be answered by all the flags, and then the headmost and weathermost ships are to make sail first. When the fleet is sailing large, or before the wind, and the admiral would bring them to, and lie by with their starboard-tacks aboard, he puts out four lights in the fore-shrouds, and fires six guns; but if with the larboard-tacks aboard, he fires eight guns, which are to be answered by the flag-ships, and every private ship must shew four lights. The windward ships must bring to first. Whenever the admiral alters his course, he fires one gun, without altering his lights, which is to be answered by all the flag-ships. If any ship have occasion to lie short, or by, after the fleet has made sail, he is to fire one gun, and shew three lights in the mizzen-shrouds. When any one first discovers land, or danger, he is to shew as many signs as he can, to fire one gun, and to tack or bear away from it; and if any one happens to spring a leak, or be disabled from keeping company with the fleet, he hangs out two lights of equal height, and fires guns till he is relieved by some ship of the fleet. If any one discovers a fleet, he is to fire guns, make false fires, put one light out on the main-top, three on the poop, to steer after them, and to continue firing of guns, unless the admiral calls him off by steering another course, and firing two or three guns; for then he must follow the admiral. When the admiral anchors, he fires two guns, a small space of time one from the other, which are to be answered by the flag-ships, and every private ship must shew two lights. When the admiral would have the fleet to moor, he puts a light on each top-mast head, and fires a gun, which is to be answered by the flag-ships, and every private ship is to shew one light. If he would have them lower their yards and top-masts, he hoists one light upon his ensign-staff, and fires one gun, which is to be answered by the flag-ships, and every private ship is to shew one light. And when he would have them hoist their yards and top-masts, he puts out two lights, one under the other, in the mizzen-top-mast shrouds, and fires one gun, which is to be answered by the flag-ships, and each private ship must shew one light in the mizzen-shrouds. If any strange ship be discovered coming into the fleet, the next ship is to endeavour to speak with her, and bring her to an anchor, and not suffer her to pass through the fleet. And if any one discovers a fleet, and it blows so hard that he cannot come to give the admiral timely notice, he is to hang out a great number of lights, and to continue firing gun after gun, till the admiral answers him with one. When the admiral would have the fleet to cut or slip, he hangs out four lights, one at each main-yard-arm and at each fore-yard-arm, and fires two guns, which are to be answered by the flag-ships, and every private ship is to shew one light.

*Signals in a Fog.*—Fog signals can only be composed of sound at different intervals. When, therefore, the admiral would have them weigh, he fires ten guns, which every flag-ship is to answer. To make them tack, he fires four guns, which are to be answered by the flag-ships, and then the leewardmost and sternmost ships must tack first, and after they are about, to go with the same sail they tacked with, and not to lie by, expecting the admiral to come a-head, and this is to avoid the danger of running foul of one another in thick weather. When the admiral brings to, and lies with his head-sails to the mast, if with the starboard tack aboard, he fires six guns; but if with the larboard tack, he fires eight guns, which the flag-ships are to answer. And, after this, if he make sail, he fires ten guns, which the flag-ships must answer, and then the headmost and weathermost ships are to make sail first. If it grow thick and foggy weather, the admiral will continue sailing with the same sail set that he had before it grew foggy, and will fire a gun every hour, which the flag-ships must answer by firing of muskets, beating of drums, and ringing of bells. But if he be forced to make either more or less sail than he had when the fog began, he will fire a gun every half hour, that the fleet may discern whether they come up with the admiral, or fall astern of him; and the flags and private ships are to answer as before. If any one discovers danger which he can avoid, by tacking and standing from it, he is to make the signal for tacking in a fog; but if he should chance to strike and stick fast, he is to fire gun after gun, till he thinks the rest have avoided the danger. When the admiral would have the fleet to anchor, he fires two guns, which the flags are to answer; and after he has been half an hour at anchor, he will fire two guns more, to be answered by the flags, as before, that all the fleet may know it.

*Signals for calling Officers on board the Admiral.*—When the admiral puts abroad an union-flag in the mizzen-shrouds, and fires a gun, all the captains are to come aboard him; and if with the same signal there be also a waft made with the ensign, then the lieutenant of each ship is to come on board. If an ensign be put abroad in the same place, all the masters of the ships of war are to come on board the admiral. If a standard on the flag-staff be hoisted at the mizzen-top-mast head, and a gun fired, then all the flag-officers are to come on board the admiral. If the English flags only, then a standard in the mizzen-shrouds, and fire a gun; if the flags and land general officers, then the admiral puts abroad a standard at the mizzen-top-mast head, and a pendant at the mizzen-peek, and fires a gun. If a red flag be hoisted in the mizzen-shrouds, and a gun fired, then the captains of his own squadron are to come aboard the admiral; and if with the same signal there be also a waft with the ensign, the lieutenant of each ship must come on board. If he hoists a white flag, as before, then the vice-admiral, or he that commands in the second post, and all the captains in his squadron, are to go on board the admiral; if a blue flag, &c. then the rear admiral, and the captains of his squadron, must come on board; and if a waft, as before, the lieutenants. When a standard is hoisted on the ensign-staff, and a gun fired, the vice and rear admirals must come on board the admiral's ship. When the admiral would speak with the captains of his own division, he will hoist a pendant on the mizzen-peek, and fire a gun; and if with the lieutenants, a waft is made with the ensign, and the same signal; for whenever he would speak with the lieutenants of any particular ship, he makes the signal for the captain, and a waft also with the ensign. When the admiral would have all the tenders in the fleet come under his stern, and speak with them, he hoists a flag, yellow and white, at the mizzen-peek, and fires a gun; but if he would speak with any particular ship's tender, he makes a signal for speaking with the captain she tends upon, and a waft with a jack. If all the pinnaces and barges are to come on board, manned and armed, the signal is a pendant on the flag-staff, hoisted on the mizzen-top mast head, and a gun fired; and if he would have them chase any ship, vessel, or boat in view, he hoists the pendant, and fires two guns. The signal for the long-boats to come on board him, manned and armed, is the pendant hoisted on the flag-staff, and the mizzen-top-mast head, and a gun fired; and if he would have them chase any ship, vessel, or boat, in open view, without coming on board him, he hoists the pendant as aforesaid, and fires two guns. When the admiral would have all the boats in the fleet to come on board him, manned and armed, he hoists a pendant on the flag-staff, both on the fore-top-mast and mizzen-top-mast head, and fires one gun; but if he would have them chase, he hoists his pendant, as before, and fires two guns. When the admiral would speak with the victualler or his agent, he puts an English ensign in the mizzen-top-mast shrouds; and when with him that has the charge of the gunner's stores, he will spread an ensign at his main-top-sail yard-arm.

*Signals for Battle.*—When the admiral would have the fleet form a line of battle, one ship ahead of another, he hoists an union-flag at the mizzen-peek, and fires a gun, and every flag-ship does the same. But when they are to form a line of battle, one abreast of another, he hoists a pendant with the union-flag, &c. When he would have the admiral of the white, or him that commands in the second post, to tack, and endeavour to gain the wind of the enemy, he spreads a white flag under the flag at the main-top-mast head, and fires a gun; and when he would have the vice-admiral of the blue do so, he doth the same with the blue flag. If he would have the vice-admiral of the red do so, he spreads a red flag from the cap, on the fore-top-mast head, downward on the back stay; if the vice-admiral of the blue, he spreads a blue flag, &c. and fires a gun. If he would have the rear-admiral of the red do so, he hoists a red flag at the flag-staff at the mizzen-top-mast head; if the rear-admiral of the white, a white flag; if the rear-admiral of the blue, a blue flag, and under it a pendant of the same colour, with a gun. If he be to leeward of the fleet, or any part of it, and he would have them bear down into his wake or track, he hoists a blue flag at the mizzen-peek, and fires a gun. If he would be to leeward of the enemy, and his fleet, or any part of it, be to leeward of him, in order to bring those ships into a line, he bears down with a blue flag at the mizzen-peek, under the union-flag, which is the signal for battle, and fires a gun; and then those ships that are to leeward of him must endeavour to get into his wake or track, according to their station in the line of battle. When the fleet is sailing before the wind, and he would have him who commands in the second post, and the ship of the starboard quarter, to clap by the wind and come to the starboard tack, he hoists a red flag at the mizzen-top-mast head; but a blue one, with a gun, if he would have ships of the larboard quarter come to the larboard tack. If the van are to tack first, he spreads the union-flag at the flag-staff, on the fore-top-mast head, and fires a gun, if the red flag be not abroad; but if it be, then he lowers the fore-top-sails a little, and the union is spread from the cap of the fore-top-mast downwards, and every flag-ship does the same. If the rear be to tack first, he hoists the union-flag on the staff-flag at the mizzen-top-mast head, and fires a gun, which all the flag-ships are to answer. If all the flag-ships are to come into his wake or track, he hoists a red flag at his mizzen-peek, and fires a gun, and all the flag-ships must do the same. If he would have him who commands in the second post of his squadron to make more sail, though himself shorten sail, he hoists a white flag on the ensign-staff; but if he who commands in the third post be to do so, he hoists a blue flag, and fires a gun, and all the flag-ships must have the same signal. Whenever he hoists a red flag on the flag-staff at the fore-top-mast head, and fires a gun, every ship in the fleet must use their utmost endeavour to engage the enemy in the order prescribed them. When he hoists a white flag at his mizzen-peek, and fires a gun, then all the small frigates of his squadron that are not of the line of battle are to come under the stern. If the fleet be sailing by a wind in the line of battle, and the admiral would have them brace their head-sails to the mast, he hoists up a yellow flag on the flag-staff at the mizzen-top-mast head, and fires a gun, which the flag-ships are to answer, and then the ships in the rear must brace first. After this, if he would have them fall their head-sails and stand on, he hoists a yellow flag on the flag-staff of the fore-top-mast head, and fires a gun, which the flag-ships must answer, and then the ships in the van must fall first and stand on. If when this signal is made the red flag at the fore-top-mast head be abroad, he spreads the yellow flag under the red. If the fleets, being near one another, and the admiral would have all the ships to tack together, the sooner to lie in a posture to engage the enemy, he hoists an union-flag on each flag-staff at the fore and mizzen-top-mast heads, and fires a gun; and all the flag-ships are to do the same. The fleet being in a line of battle, if he would have the ship that leads the van hoist, lower, set, or haul up any of the sails, he spreads a yellow flag under that at his mizzen-top-mast head, and fires a gun, which signal the flag-ships are to answer, and then the admiral will hoist, lower, set, or haul up the sail which he would have the ship that leads the van do, which is to be answered by the flag-ships of the fleet. When the enemy runs, and he would have the whole fleet follow them, he makes all the sail he can after them himself, takes down the signal for the line of battle, and fires two guns out of his bow-chase, which the flag-ship answers; and then every ship is to endeavour to come up with and board the enemy. When he would have the chase given over, he hoists a white flag at the fore-top-mast head, and fires a gun. If he would have the red squadron drawn into a line of battle, one abreast of another, he puts abroad a flag, striped red and white, on the flag-staff at the main-top-mast head, with a pendant under it, and fires a gun. If the white, or second squadron, be to do so, the flag is striped red, white, and blue; if the blue, or third squadron, be to do so, the flag is a Genoese ensign and pendant; if they are to draw into a line of battle, one ahead of another, the same signals are made without a pendant. If they are to draw into the line of battle, one astern of another, with a large wind, and he would have the leaders go with the starboard tacks aboard by the wind, he hoists a red and white flag at the mizzen-peek, and fires a gun; but if they should go with the larboard tacks aboard by the wind, he hoists a Geonese flag at the same place, which signals, like others, must be answered by the flag-ships.

*Signals in Distress and for Relief.*—Signals betokening distress have been already intimated in the foregoing; we shall, therefore, subjoin an account of signals in case ships or vessels are perceived in distress. The following are the charitable institutions established at Bembrough Castle, in the county of Northumberland, for the assistance and relief of distressed mariners, published by the direction of the trustees of Nathaniel, late Lord Crewe, with the approbation of the master, pilots, and seamen of the Trinity House, Newcastle. 1. A gun, (a nine-pounder) placed at the bottom of the tower, to be fired as a signal in case any ship or vessel be observed in distress; viz. once, when any ship or vessel is stranded, or wrecked, upon the islands, or any adjacent rock. Twice, when any ship or vessel is stranded, or wrecked, behind the castle, or to the northward of it. Thrice, when any ship or vessel is stranded, or wrecked, to the southward of the castle, in order that the

Custom-house officers and the tenants, with their servants, may hasten to give all possible assistance, as well as to prevent the wreck from being plundered. 2. In every great storm two men on horseback are sent from the castle to patrole along the coast from sun-set to sun-rise, that in case of any accident, one may remain by the ship, and the other return to alarm the castle. Whoever brings the first notice of any ship or vessel being in distress, is entitled to a premium in proportion to the distance from the castle; and if between twelve o'clock at night and three o'clock in the morning, the premium to be doubled. 3. A large flag is hoisted when there is any ship or vessel seen in distress upon the Fern Islands, or Staples, that the sufferers may have the satisfaction of knowing their distress is perceived from the shore, and that relief will be sent them as soon as possible. In case of bad weather, the flag will be kept up, a gun fired morning and evening, and a rocket thrown up every night from the north turret, till such time as relief can be sent. There are also signals to the Holy Island fishermen, who, from the advantage of their situation, can put off for the islands at times when no boat from the main land can get over the breakers. Premiums are given to the first boats that put off for the islands, to give their assistance to ships or vessels in distress, and provisions are sent in the boat. 4. A bell on the south turret will be rung in every thick fog, as a signal to the fishing-boats; and a large swivel fixed on the east turret, will be fired every fifteen minutes, as a signal to the ships without the islands. 5. A large weather-cock is fixed on the top of the flag-staff, for the use of the pilots. 6. A large speaking-trumpet is provided, to be used when ships are in distress near the shore, or are run aground. 7. An observatory, or watch-tower, is built on the east turret of the castle, where a person is to attend every morning at daybreak during the winter season, to look out if any ships are in distress. 8. Masters and commanders of ships and vessels in distress, are desired to make such signals as are usually made by people in their melancholy situation. Besides these signals for affording relief, stores, provisions, necessary articles for raising ships that are stranded, in order to their being prepared. Coffins for the dead, &c. are also provided.

*Day* SIGNALS, are usually made by flags and pendants, sometimes accompanied with one or more guns.

*Night* SIGNALS, are either lanterns disposed in certain figures, as lines, squares, and triangles, or are made with false fires, &c.

*Fog* SIGNALS, consist of operations which emit sound, as firing cannon or muskets, beating drums, ringing bells, &c.

SIGNATURE, a subscription, or putting one's name at the bottom of an act or deed, in personal hand writing, or mark.

SIGNATURE, in Printing, is a letter put at the bottom of the first page, at least, in each sheet, as a direction to the binder in folding, gathering, and collating them.

SIGNET. *See Sign* MANUAL.

SIGNIFICATION, the sense or meaning of a word, phrase, emblem, or device. The signification of the ancient hieroglyphics is but little known.

SIGNINUM, among the Romans, was a kind of pavement much esteemed. It was made of powdered shells mixed with lime.

SIGN-MANUAL, in Law, is used to signify a bill or writing signed by the king's own hand.

SIKE, a term provincially applied to a little rill, a water furrow, and a gutter.

SIL, in Canals, the bottom timbers of sluices, lockgates, &c.

SIL, in Natural History, peculiar kinds of ochres, well known as valuable paints.

SILICA, SILEX, SILICIUM, or *Silicious Earth*, is one of the most abundant substances in nature, and is the chief component part of sand, sandstone, flints, granite, quartz, porphyry, rock crystal, agates, and many precious stones. It is the substance of which the solid frame of many mountains is composed, and it probably is so of a great part of the globe itself. Its specific gravity is about 2·66. Silex when perfectly pure is a fine powder, hard, insipid, and without smell; rough to the touch, and scratches and wears away glass. When mixed with water, it does not form an adhesive soft mass, and soon falls to the bottom, leaving the water clear. If silex be very minutely divided, it may be dissolved in water to a very small degree. Although we cannot dissolve silica artificially, we find it done by nature. The Bath waters, and other mineral springs, contain silex in solution in a very small portion. The great springs and waterspouts of Geyser in the island of Iceland, which project the water ninety feet high, contain silex dissolved by some process of nature, for the water falling down deposits such a quantity of silicious earth as to form a sort of cup around the spring. In this process the pressure and heat of the water may, perhaps, greatly contribute to the effect. Silica is a very necessary component part in good mortar. When reduced to minute parts either by nature or art, it is employed in making stone-ware. It is the chief substance of which glass is made, for which purpose it is smelted with the alkaline salts in a great heat. A variety of these salts are used for the purpose, and metals are also frequently employed. Silica, it is probable, is composed of oxygen and a metallic basis.

SILK, the web or envelopment of the caterpillar, of a species of moth called the Phalena mori, which being convertible to various purposes of utility and elegance, forms an important article in commerce, as the material of a valuable manufacture. The caterpillar, or silk-worm, when full grown, encloses itself in a loose web, in the midst of which it forms a much closer case or covering, of an oval form, and varying in colour from white to a deep orange, but usually of a bright yellow colour. In this case, or ball, the animal becomes a crysalis, and remains enclosed about fifteen days; when having resumed active life, in the form of a moth, it makes a hole at one end of its prison, and comes out. This, as it destroys the silk-ball, is prevented, in those countries where silk is cultivated, by killing the crysalides by means of heat. The culture of silk varies but little in different countries, and does not require any great degree of skill, or considerable capital; and as silk-worms, cherished with care, and attended as matters of curiosity, were found to thrive and multiply in England, it is not surprising that attempts should have been made to establish the culture of it in this country. The success of Henry IV. of France, in extending the culture of silk, which before his time had been confined to a few districts of that kingdom, excited in James I. an active zeal for the introduction of it here. The insurmountable obstacle to raising silk in Great Britain is the climate, which is too cold and wet; and though expedients might be adopted to obviate these inconveniencies, they would render the culture of the article, on a large scale, by far too expensive. In the British settlements in the East Indies, the culture of silk has been long established, particularly in the island of Cossimbwzar and its neighbourhood, in the province of Bengal; and since, about the year 1760, when the company became the rulers of the country, and adopted a new system of trade for the purpose of realizing the surplus revenue, the culture of raw silk has been promoted, and the quantity considerably increased. Of late years, considerable attention has been paid both to the quality of the silk, and to the mode of reeling it, by which it has been very materially improved, so as to rival, in most respects, the produce of Italy.

SILVER, is the whitest of all metals, considerably harder than gold, very ductile and malleable, but less malleable than gold; for the continuity of its parts begins to break when it is hammered out into leaves of about the hundred and sixty thousandth part of an inch thick, which is more than one-third thicker than gold leaf; in this state it does not transmit the light. Its specific gravity is from 10·4 to 10·5. It ignites before melting, and requires a strong heat to fuse it. The air alters it very little, though it is disposed to obtain a thin purple or black coating from the sulphurous vapours which are emitted from animal substances, drains, or putrefying matters. This coating, after a long series of years, has been observed to scale off from images of silver exposed in churches; and was found, on examination, to consist of silver united with sulphur. Silver is soluble in the sulphuric acid when concentrated and boiling, and the metal in a state of division. The muriatic acid does not act upon it, but the nitric acid, if somewhat diluted, dissolves it with great rapidity, and with a plentiful disengagement of nitrous gas.

SILVERING, performed as gilding, is the application of silver leaf to wood, paper, and other substances.—*To Silver Copper or Brass*, cleanse the metal with aqua fortis, by washing it lightly, and then plunging it into water; or by scouring it with salt and tartar with a wire brush. Dissolve silver in aqua fortis, put copper into the solution; this will precipitate the silver in the state of a metallic powder. Take about twenty grains of this silver powder, and mix with it two drachms of tartar, the same quantity of common salt, and half a drachm of alum; rub the articles with this composition till they are perfectly white, then brush it off, and polish it with leather. Another method: precipitate silver from its solution in aqua fortis by copper, as before; to half an ounce of this silver add common salt and sal ammoniac, of each two ounces, and one drachm of corrosive sublimate; rub them together, make them into a paste with water; and with this, copper utensils of every kind, that have been previously boiled with tartar and alum, are rubbed; after which they are made red hot and polished.—*To Silver Dial-plates of Clocks, &c.* take half an ounce of silver leaf, add to it an ounce of double-refined aqua fortis, put them into an earthen pot, place them over a gentle fire till the whole is dissolved; then take off the pot, and mix the solution in a pint of clear water; after which, pour it into another clean vessel, to free it from grit or sediment; add a spoonful of common salt, and the acid, which has now a green tinge, will immediately let go the silver particles, which form themselves into a white curd; pour off the acid, mix the curd with two ounces of salt of tartar, half an ounce of whiting, and a large spoonful of salt, and mix it well up together, when it will be ready for use. Having cleared the brass from scratches, rub it over with a piece of old hat and rotten-stone, to clear it from all greasiness, and then rub it with salt and water with your hand, take a little of the composition just described on your finger, rub it over where the salt has touched, it will adhere to the brass, and completely silver it. Then wash it well with water, to take off what aqua fortis may remain in the composition; when dry, rub it with a clean rag, and give it one or two coats of varnish, prepared according to the directions already given. This silvering, though not durable, may be improved by heating the article, and repeating the operation till the covering seems sufficiently thick.—*Silver Plating*, the coat of silver applied to the surface of the copper by the means just mentioned, is thin, and not durable. A method more substantial is as follows: form small pieces of silver and copper, tie them together with wire, putting a little borax between, (the proportion of silver may be to that of the copper as 1 to 12;) subject them to a white heat, when the silver will be firmly fixed to the copper. The whole is now passed between rollers, till it be of the required thickness for manufacturing articles of use or ornament.—*To make French Plate*, heat the copper articles intended to be plated, and burnish silver-leaf on it with a burnisher.—*To make Shell Silver*, grind leaf-silver with gum-water or honey; wash away the gum or honey, and the powder that remains is used with gum-water, or glaire of eggs laid on with a hair pencil.—*To Silver Looking-glasses*, you must be prepared with the following articles: First, a square marble slab, or smooth stone, well polished, and ground exceedingly true, the larger the better, with a frame round it, or a groove cut in its edges, to keep the superfluous mercury from running off. Secondly, lead weights covered with cloth, to keep them from scratching the glass, from one pound weight to twelve pounds each, according to the size of the glass which is laid down. Thirdly, rolls of tinfoil. Fourthly, mercury or quicksilver, with which you must be well provided; then proceed as follows: the tinfoil is cut a little larger than the glass every way, and laid flat upon the stone, and with a straight piece of hard wood, about three inches long, stroked every way, that there be no creases or wrinkles in it; a little mercury is then dropped upon it, and with a piece of cotton, wool, or hare's foot, spread it all over the foil, so that every part may be touched with the mercury: then keeping the marble slab nearly level with the horizon, pour the mercury all over the foil, cover it with a fine paper, and lay two weights near its lower end, to keep the glass steady, while you draw the paper from between the silver foil and the glass, which must be laid upon the paper. As you draw the paper, you must take care that no air-bubbles be left, for they will always appear, if left in at the first; you must likewise be sure to make the glass as clean as possible on the side intended to be silvered, and have the paper also quite clean, otherwise, when you have drawn the paper from under it, dull white streaks will appear, which are very disagreeable. After the paper is drawn out, place weights upon the glass, to press out the superfluous mercury, and make the foil adhere: when it has lain about seven hours in this situation, raise the stone about two or three inches at its highest end, that as much of the mercury may run off as possible; let it remain two days before you venture to take it up; but before you take the weights off, brush the edges of the glass gently, that no mercury may adhere to them; then take it up, and turn it directly over, with its face-side downward, but raise it by degrees, that the mercury may not drip off too suddenly; for if, when taken up, it is immediately set perpendicular, air will get in between the foil and the glass at the top, as the mercury descends to the bottom, and your labour will be lost. Another method is to slide the glass over the foil, without the assistance of paper. The methods of silvering glass globes, and the convex sides of meniscus glasses for mirrors, are seldom practised, except by very experienced workmen.

SIMARONA, a name given by the Spaniards in America to the bastard vanilla.

SIMAROUBA, the bark of the roots of a tree, first imported into Europe in the year 1713. It has since been ascertained to be a species of the quassia, and has been found exceedingly serviceable in many disorders.

SIMIA, the Ape, in Natural History, a genus of Mammalia, of the order Primates. Animals of this genus are commonly divided into such as have no tails; such as have only very short ones; such as have very long ones; and lastly, such as have prehensile tails, with which they can lay hold of any object at pleasure. These four classes are called respectively apes, baboons, monkeys, and japajous. In the whole genus there are enumerated by Gmelin sixty-three species, of which we shall notice some of the most important.—S. satyrus, or the ourang-outang, grows, in its native woods of Africa and India, to the height of six feet, and subsists, like most other species, on fruits. It flies from the haunts of mankind, leads a solitary life, and displays great strength, agility, and swiftness, which render it extremely difficult to be taken. It has been known to attack and destroy negroes wandering at a distance from their habitations, and to carry off women to its wretched habitation, watching them with such extraordinary vigilance, as scarcely to admit the possibility of their escape. Its general resemblance to the human figure and countenance is particularly and mortifyingly strong; yet minute observation and dissection have pointed almost innumerable differences, the detail of which is here impossible. It is capable of being tamed and domesticated, and many years one was exhibited in London, which had been disciplined to sit, and work, and eat, like a human being, using a knife and fork for the latter purpose. Its disposition was pensive; its manners were gentle; and it appeared to possess, for its keepers, and those to whom it had been long familiarized, a high degree of genuine gratitude and attachment.—The Barbary ape, is about four feet in height, and is the species most commonly exhibited in public shows, and is trained to the performance of a great variety of tricks, calculated to attract popular admiration. The discipline it passes through is often severe, and this species is considered, in its natural state, as being more ferocious, and less sagacious, than several others of the class. It undergoes accordingly much cruel usage.—The great baboon, is between three and four feet high, of a gray-brown colour, and is particularly muscular in the upper part of its body; its hands and feet have sharp nails, like claws; but on its thumbs there are nails formed like those on the human fingers. It is an animal incapable of domestication.—The dog-faced baboon, is very large, and often greater than the common baboon. It is distinguished by a vast quantity of hair, spreading from each side of the head down the shoulders, and covering the animal to the waist, like a mantle.—The proboscis monkey, is one of the most curious in its aspect, and most ludicrous of the class. It is about two feet in length.—The preacher monkey, is as large as a fox, and is extremely common in the woods of Brasil. Travellers have stated, that it is usual for one of these to ascend a tree, and, by certain sounds, to collect vast multitudes beneath him, when he commences a howl so loud as to be heard to a vast distance.—The royal monkey, is about the size of a squirrel, and inhabits the damp, woody districts of Cayenne, being never found on the mountains. In its sounds and manners it resembles the last species.

SIMILAR, a composition made of red copper and zinc, in such proportions as to imitate the colour of gold.

SIMILAR *Figures*, in Geometry, such as have their angles respectively equal, and the sides about the equal angles proportional.

SIMILE, in Rhetoric, is a comparison of two things, which, tho' unlike in other respects, yet agree in the one pointed out.

SIMILITUDE, a striking resemblance between things, which conceals for a time the distinctive marks of individual identity.

SIMITAR, or SCIMITAR, a crooked or falcated sword, having a convex edge. It is now rarely used.

SIMONIANS, in Church History, a sect of ancient Christians, so called from their founder Simon Magus, or the magician. The heresies of Simon Magus were principally his pretending to to be the great power of God, and thinking that the gifts of the Holy Spirit were venal.

SIMONY, is the corrupt presentation of any one to an ecclesiastical benefice, for money, gift, reward, or benefit; it was not an offence punishable criminally at the common law, it being thought sufficient to leave the clerk to ecclesiastical censures. But as these did not affect the simoniacal patron, none were efficacious enough to repel the notorious practice of the thing. Several acts of parliament have, therefore, been made to restrain it, by means of civil forfeitures, which that modern prevailing usage with regard to spiritual preferments calls aloud to put in execution. By one of the canons of 1603, every person, before his admission to any ecclesiastical promotion, shall, before the ordinary, take an oath, that he hath made no simoniacal contract, promise, or payment, directly or indirectly, by himself or any other, for the obtaining of the said promotion; and that he will not afterwards perform or satisfy any such kind of payment, contract, or promise by any other without his knowledge or consent. To purchase a presentation, the living being actually vacant, is open and notorious simony; this being expressly in the face of the statute. But the sale of an advowson during a vacancy is not within the statute of simony, as the sale of the next presentation is; but it is void by the common law. A bond of resignation is a bond given by the person intended to be presented to a benefice, with condition to resign the same; and is special or general. The condition of a special one is to resign the benefice in favour of some certain person, as a son, a kinsman, or friend of the patron, when he shall be capable of taking the same. By a general bond, the incumbent is bound to resign, on the request of the patron. A bond with condition to resign within three months, after being requested, to the intent that the patron might present his son when he should be capable, was held good: and the judgment was affirmed in the exchequer-chamber; for that a man may, without any colour of simony, bind himself for good reasons; as if he take a second benefice, or if he be non-resident, or that the patron present his son, to resign; but if the condition had been to let the patron have a lease of the glebe or tithes, or to pay a sum of money, it had been simoniacal.

SIMOOM. A wind or haze observed by Bruce in the course of his travels to discover the sources of the Nile, which is supposed to be in some respects analogous to the sirocco. It is called by Mr. Bruce the simoom; and from its effects upon the lungs, we can entertain but little doubt that it consists chiefly of corbonic acid gas in a very dense state, and perhaps mixed with some other noxious exhalations.

SIMPLE, in Music, a term applied to that counterpoint in which note is set against note, and which is called simple, in opposition to the more elaborate composition, known by the name of figurative counterpoint.

SIMSON, ROBERT, a celebrated mathematician, born in the county of Lanark, and educated at Glasgow. He died at the age of eighty-one.

SIN, in Theology, a want of conformity to the will of God, which comprehends sins of *omission* and sins of *commission*. Sins are distinguished by the terms *original* and *actual;* the former is the morally contaminated nature we derive from our primary progenitors, and the latter arises from our personal disobedience.

SINAPIS, MUSTARD, a genus of plants belonging to the class of tetradynamia, and to the order of siliquosa, and in the natural system ranged under the 39th order siliquosa.

SINAPIS, in Gardening, contains plants of the hardy, herbaceous, annual kind, of which species those most cultivated are, the white and black mustard.

SINCERITY, in Ethics, that excellent habitude and temper of mind which gives to virtue its reality, and makes it to be in reality what it appears.

SINE, or *Right Sine of an Arch*, in Trigonometry, is a right line drawn from one end of that arch, perpendicular to the radius drawn to the other end of the arch; being always equal to half the chord, or twice the arch.

SINECURE, is where a rector of a parish has a vicar under him endowed and charged with the cure, so that the rector is not obliged either to do duty or residence.

SINE DIE, in Law, a phrase which signifies, that judgment being given for the defendant, he is dismissed the court. The phrase is also used in parliament when a debate is adjourned, and no day fixed for its resumption. This is considered as a polite way of dismissing it altogether.

SINEW, in Anatomy, properly denotes what is called a nerve, though, in common speech, it more generally signifies a tendon. The Jews will not eat the sinew of the thigh of any animal, in memory of the sinew of Jacob's thigh, which was touched by an angel.

SINGING, the art of making divers inflexions of the voice, agreeable to the ear, and corresponding to the notes of a song, or piece of melody.

SINKING FUND, a portion of the public revenue set apart to be applied to the reduction or discharge of the public debts. The appropriation of a part of the revenue to this purpose is a measure which had been adopted in other countries, long before any necessity for it existed in England; a provision of this kind having been established in Holland in 1655, and in the ecclesiastical state in 1685.

SINUOSITY, a series of bends, curves, or other irregular turns and figures; sometimes rising, sometimes sinking, such as is described by the motions and contortions of serpents, the windings of rivers, and the indentations and projections of the sea-coast.

SIPHENIA, in Botany, a tree from which issues a resinous exudation so well known under the appellations of caoutchouc, elastic gum, and Indian rubber. For the manner in which Indian rubber is made, see CAOUTCHOUC.

SIPHON, or SYPHON, in Hydraulics, a bended pipe having the air sucked out of it, and, with one end placed in a vessel containing any liquid, is used to draw off the liquor at the other.

SIPHURIUS LAPIS, a steatite substance, found in the island Siphnos, in the Ægean sea, and dug up in large masses near the coast. This substance being soft when found, was easily wrought into various kinds of vessels, which, being burnt and oiled, became black, solid, susceptible of a fine polish, and capable of enduring a great degree of heat. Under the name of Lapis Lebitum, the same substance is still known in many parts of Europe. In its native state, it is said to resemble the soap rock.

SIPONCULUS, or TUBE-WORM, a genus of insects of the order vermes intestina; the generic character is, body round, elongated; mouth cylindrical at the end, and narrower than the body; aperture at the size of the body, and veruciform.

SIREN, in fabulous history, the *Mermaid;* and sometimes the term is applied to imaginary sea nymphs, or sea sorceresses, who allure mariners to their fate.

SIREN, in Natural History, a genus of Amphibia, of the order reptiles, or of the order meantes, an order instituted by Linnæus on account of this genus of animals alone. The eel-siren is most nearly allied to the lizard tribe, but differs from it in having only two feet, and those armed with claws; the body is shaped like an eel; its colour is a dark brown speckled with white; it is often more than two feet long, and inhabits the stagnant waters of South Carolina; sometimes, however, quitting water for the land.

The anguine siren, is a native of a particular lake in Carniola, from which the water regularly drains off during the summer; during which time the bottom produces corn or pasture. In

In autumn the water returns with considerable rapidity, flowing principally from springs in the neighbouring fountains. In this lake this siren is found of the length of eleven inches, and of a pale rose colour. It has both fore and hind legs. Its movements are extremely slow and weak when it is placed in a vessel, either with or without water; but in its native situation it is far more active It is by some supposed to be the larva of a lizard, and by others imagined to be a complete animal. Its habits are predatory, and it subsists on the smaller inhabitants of the water.

SIRI, among the Romans, were subterraneous vaults or caves, in which wheat could be kept sound and fresh for fifty years.

SIRIUS, in Astronomy, the dog-star in the constellation of Canis Major, south-east of Orion. It is the most brilliant star that appears in the heavens, and is therefore thought to be nearer to us than any other. *See* ORION.

SIROC, or SIROCCO, a periodical wind which visits Italy, Dalmatia, and Sicily about Easter. It is attended with such a strong degree of heat, that at Palermo it has been compared to a blast of burning steam, issuing from the mouth of a hot oven. It rarely continues at one visit more than forty hours, but during this time, the inhabitants remain within their houses, otherwise life would be scarcely supportable. Its effects are debilitating, but it has not been accused of generating any particular disease.

SITE, or SCITE, denotes the situation of a house, messuage, mansion, village, or town, and not unfrequently the ground on which either is supposed to stand.

SKATE, a sort of shoe armed with a strong rib of steel, for sliding on the ice. The exercise of skating, carried to a certain degree of perfection, surpasses all other pastimes, in the beauty of its movements, and the variety and rapidity of its graceful attitudes. The dexterity with which an experienced skater will pass through his numerous and intricate evolutions is truly astonishing; and to those who are not intimately acquainted with the laws of gravitation, his surprising agility has all the appearance of enchantment. To those who begin when young, under the tuition of an experienced skater, the exercise is learned with great facility. It cannot, however, be denied, that it is frequently attended with danger, for scarcely a winter passes in which, through the breaking of the ice, several lives are not lost. Some skaters have been known to travel fifteen miles an hour.

SKEET, a sort of long scoop used to wet the sides of a ship, in order to keep them cool, and prevent them from splitting by the heat of the sun. It is also employed in small vessels, to wet the sails, to render them more efficacious in light breezes: this operation is sometimes performed in large ships by means of the fire-engine.

SKELETON, all the bones of a dead animal, dried, cleansed, and disposed in their natural situation.

SKIDS, or SKEEDS, long compassing pieces of timber, formed to answer the vertical curve of a ship's side. They are notched below, so as to fit closely upon the wales, and extend from the main-wale to the gunnel, being strongly nailed to the side. Their use is to preserve the plank of the side when any weighty body is hoisted or lowered against it.

SKIFF, a small light boat, resembling a yawl; also a wherry without masts or sails, usually employed to pass a river.

SKIM COULTER, in Agriculture, a sort of coulter invented by Mr. Ducket, for paring off the surface of coarse grass or other lands, and placing it in the bottom of the furrow, so as to be fully covered and secured. This coulter is connected with the plough that turns the furrow.

SKIM *Milk*, that sort of milk which is left after the cream has been taken off its surface.

SKIM *Milk Cheese*, an inferior kind of cheese made from skimmed milk.

SKIN, in Anatomy, a large thick membrane spread over the whole body, serving as an external organ of feeling, and as an ornament and covering to the parts beneath.

SKIN, in rural economy, is the hide of any animal, and is applied to numerous purposes besides its principal one, that of being made into leather.

SKIRMISH, in War, an irregular kind of combat between small parties in sight of their respective armies. These combatants are sometimes directed thus to advance, and commence an encounter, in order to bring on a general engagement.

SKULL, that part of the head which forms its great bony cavity.

SKY, the blue expanse with which the globe is encircled. The azure colour of the sky Sir Isaac Newton attributes to vapours beginning to condense therein, which have consistence enough to reflect the more violent rays, but not enough to reflect the less reflexible ones.

SKY *Scrapers*, small triangular sails, sometimes set above the royals; they are, however, very rarely used.

SLAB, an outside sappy plank or board sawed off from the sides of a timber tree: the word is also used for a flat piece of marble.

SLAB *Lines*, small cords passing up behind a ship's main-sail or fore-sail, and being reeved through blocks attached to the lower part of the yard, are thence transmitted each in two branches to the foot of the sail, where they are fastened. They are used to truss up the sail, but more particularly for the convenience of the steersman, that he may look forward beneath it.

SLACK OF A ROPE, that part which hangs loose, as having no strain or stress upon it. *Slack Rigging*, implies that the shrouds, stays, &c. are not so firmly extended as they ought to be. *Slack in Stays*, signifies slow in going about. *Slack Water*, the intervals between the flux and reflux of the tide, or that time during which the water apparently remains in a state of rest.

SLAG, denotes vitrified cinders. In some places it is used in buildings, and in repairing roads.

SLAKE, the saturating of quicklime with water, or other moisture.

SLAKED LIME, such as is reduced to a state of powder by the action of water upon it, or the hydrate of lime. In this case the lime is combined with about one-third of its weight o water.

SLAKEN, in Metallurgy, a term used by smelters to express a spongy semivitrified substance, which they mix with ores of metal to prevent their fusion. It is the scoria, or scum, separated from the surface of a former fusion of metals.

SLAM, the refuse of alum works, which is used as a manure, mixed with sea-weed and lime, in Yorkshire.

SLAP-DASH, in Building, provincially rough casting. It is a composition of lime and coarse sand reduced to a liquid state, and applied to the exterior of walls, as a coating that is both preservative and ornamental.

SLATCH, the period of a transitory breeze, or the length o its duration.

SLATE, a well-known, neat, convenient, and durable material for the covering of the roofs of buildings. There are great varieties of this substance, and it likewise differs very greatly in its qualities and colours. In some places it is found in thick lamina, or flakes, while in others it is thin and light. The colours are white, brown, and blue. It is so durable in some cases as to have been known to continue sound and good for centuries.

SLAVES and SLAVERY. Slavery, in its proper and detestable signification, is a system which gives to the master an absolute power over the destiny and life of the slave. By the laws of England, and the uncorrupted feelings of Englishmen, it is held in the utmost abhorrence; nor is it suffered to pollute our atmosphere or soil. The instant a slave puts his foot on British ground, the laws take him under their protection, and he is declared free. Yet, unhappily, it still continues in our West India islands, to the disgrace of the British name; and in other countries, to the lasting reproach and dishonour of human nature.

SLEAZY HOLLAND, a slight Holland, thus called because made in Silesia, in Germany. The texture being thin, all slight, ill-woven Hollands have obtained the name of sleasy.

SLEDGE, a kind of carriage without wheels, for the conveyance of very weighty things, as huge stones, &c.

SLEEP, in Physiology, the greater or less suspension of the functions of sensation and volition. The phenomenon of sleep has given rise to many curious speculations, inquiries, and theories; but its real nature is better known from fact and experience, than from any philosophical investigations.

**SLEEPERS**, in a Ship, timbers lying before and aft, in the bottom of the ship, as the rung-heads do; the lowermost of them is bolted to the rung-heads, and the uppermost to the futtocks and rungs.

Sleepers, a name given to some animals that sleep during the winter, such as bears, marmots, dormice, bats, hedgehogs, &c.

Sleepers, in the glass manufactories, are large iron bars crossing the smaller ones, and hindering the passage of the coals, but leaving room for the ashes to descend.

Sleepers, among Carpenters, are pieces of wood to support joists, also a name formerly given by shipwrights to the thick stuff placed longitudinally in a ship's hold, opposite to the several scarfs of the timbers, but now generally applied to the knees which connect the transoms to the after timbers on the ship's quarter. They are particularly used in Greenland ships, to strengthen the bow and stern-frame, to enable them to resist the shocks of the ice.

**SLICH**, the ore of any metal, particularly of gold, when it has been pounded and prepared for further working.

**SLIDE-BUTT**, in Agriculture, a sort of sledge in the form of a strong oblong box, shod underneath with thick pieces of timber. It is chiefly used for drawing manure from place to place, but chiefly in fields. It will contain about three wheel barrows' full. Sometimes the butt has wheels, and when this is the case it is called *gurry*.

**SLIDING**, in Mechanics, is when the same point of a body, moving along a surface, describes a line without revolving.

**SLIME**, a soft muddy substance left by tides and other waters, in different places, which, mixed with other materials, become an useful manure.

**SLING**, an instrument serving for casting stones with great violence. The inhabitants of the Balearic islands were famous in antiquity for the dexterous management of the sling; it is said they bore three kinds of slings, some longer, others shorter, which they used according as their enemies were nearer or more remote. It is added that the first served them for a head-band, the second for a girdle, and that a third they constantly carried with them in hand.

**SLINGING**, is used variously at sea, but chiefly for the hoisting up casks, or other heavy things, with slings.

**SLINGS**, a rope fitted to encircle a cask, jar, bale, or case, and suspend it while hoisting and lowering. Of these there are various sorts, according to the weight or figure of the object to which they are applied. *Slings of a Yard*, ropes fixed round its middle, and serving to suspend it for the greater ease of working, or for security in an engagement; in the latter case they usually add iron chains to the slings of the lower yards. This term also implies the middle, or that part of the yard on which the slings are placed. *Boat-Slings*, strong ropes, furnished with hooks and iron thimbles, whereby to hook the tackles, in order to hoist the boats in or out of the ship, the hooks of the slings being applied to ring-bolts fixed in the keel and extremities of the boat. *Butt-Slings*, are those used in lading and delivering ships, and are nearly in the form of a pair of spectacles.

**SLIP**, a place lying with a gradual descent on the banks of a river, or harbour, convenient for ship-building.

*Ship* Slip, *Morton's Patent for Hauling Vessels out of the Water for Repairs, &c.*—A carriage is constructed, as represented in the plan, p. 944, with truck-wheels to run upon the iron railways of the inclined plane, these truck-wheels having flanges to guide them. Blocks are laid upon the keel-beam of the carriage, to a sufficient height, so that the keel of the vessel clears the ends of the cross pieces; and each block embraces four trucks—two on each side of the beam. The blocks which slide upon the cross pieces, are made up to correspond to the rising of the vessel's bottom. These blocks are run out to the extremity of the cross pieces, and their ropes, crossing the carriage, are reeved through a sheave attached to the opposite cross piece, up to the top of the rope rod. The shores (if any are necessary) are put into their places, turn upon a joint at their heel, and are secured (while the vessel is floating on,) from falling outwards by a small chain. The carriage, thus prepared, is let down the inclined plane generally at low water, but if found expedient, into the water, (as the weight of the metal attached thereto keeps it down in its place,) sufficiently far to allow the vessel to float upon it. The chain-purchase is attached to the carriage: and a water-staff is placed at the fore-end of the keel-beam, to mark the depth of water, and be a guide in floating the vessel on. The vessel is brought to the end of the carriage, and hauled over it, (having bow and quarter lines to steady her,) till her fore-foot, or advanced part of the keel, takes the blocks between the fore-foot guides. The ends of the sliding block-ropes are now taken from the rods on board, but kept slack; she is still hauled forward as the water flows, until the keel takes the blocks at the contracted part of the guides, which are just wide enough to receive it. Being still afloat abaft, having been previously so trimmed,) the vessel is then adjusted over the blocks abaft by the water line. When the iron guides are hauled up, they will confine her to settle down truly. By heaving the purchase, she will soon take the blocks abaft, which is observed by the water-mark left on her bottom; she is trimmed upright, and the foremost bilge, or sliding-blocks, hauled in tight. As she rises out of the water, each succeeding block is hauled in, but not till the weight of the vessel has settled well on her keel. The sliding-blocks are prevented from springing back, by their palls falling into their racks; the shores are brought to her sides, and cleared. When thus secured, she is hauled up the inclined plane, at the rate of from 2½ to 5 feet per minute, by six men to every hundred tons. Being hauled up, she is shored from the ground; the keel-beam is secured from moving; and the sliding-blocks, with their cross pieces, are in a few minutes removed, when the vessel is ready to be repaired. The blocks being relieved of the vessel in the usual manner, the keel beam, with the after cross beam, will run from under her. The carriage is again put together, and another vessel can be hauled up astern of the former. When a vessel is to be launched, the cross pieces, with their blocks, are put under her, and instantly let into the water; or, to launch and haul up vessels the same tide, temporary blocks are put under the bottom of the vessel to be launched upon the cross pieces, instead of the sliding blocks, which are prepared as before, to suit the bottom of the vessel to be taken up; the vessel is launched; when she, and the temporary blocks which steadied her, float from the carriage, and the other vessel is taken on, and hauled up as formerly.

*Advantages of this Invention.*—1st. The vessel being above ground, the air has a free circulation to her bottom, thereby requiring no firing; the men work with much more comfort, of course quicker, and in winter, particularly, they have light better and much longer, than within the walls of a dry dock; considerable time is also saved in carrying and removing the materials for repairing the vessel.

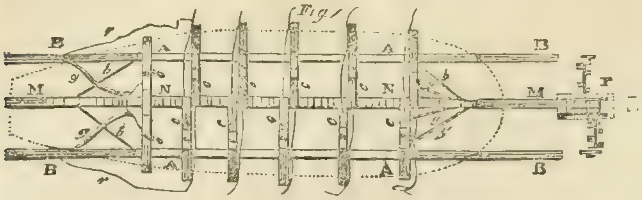
2nd. Such is the facility of its operation, that ships can be hauled up, inspected, and even get a trifling repair, and be launched the same tide; and the process of repairing one vessel is never interrupted by hauling on another, as is the case in dry docks, from the necessity of letting in the water.

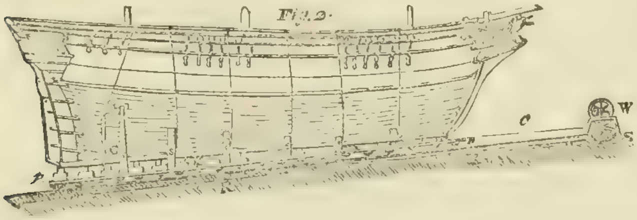
3d. The vessel is hauled up the inclined plane at the rate of 2½ to five feet per minute, by six men to every hundred tons; so that the expense of hauling up and launching a vessel from 200 to 300 tons, does not exceed thirty shillings 4th. A slip can be constructed at about one-tenth the expense of a dry dock, and be laid down in situations where it is impossible to have a dock built.

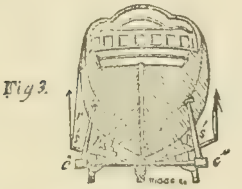
4th. There is no previous preparation, or fitting bilge-ways, necessary.

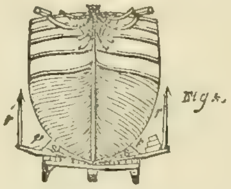
The chain of the mechanical power is attached solely to the carriage on which the vessel is floated; therefore the vessel is exposed to no strain. The whole apparatus can be removed from one place to another, and be carried on ship-board.

*Description of the Drawings*,—A, A, A, A, side beams of the carriage, with trucks or rollers beneath, at each cross piece; B B, B, B, sideway; *c*, *c*, *c*, *c*, *c*, *c*, *c*, cross pieces; $c'$, $c'$, cross-pieces, which racks; $c''$ $c''$, aftermost cross pieces; *b*, *b*, braces, *g*, *g*, iron guides; $b'$, $b'$, oblique braces; $g'$, $g'$, guides to receive the fore-foot of the vessel; *s*, *s*, *s*, *s*, *s*, *s*, *s*, *s*, *s*, *s*, sliding blocks; *r*, sliding-block rope; $s'$, $s'$, shore; $r'$, $r'$, rope for hauling guide or crutch, M, midway, with rack; N, N, main or keel beam of the carriage; P, purchase; W, wheel or pinion, capstan, or other purchase; S, large stones; C, chain; K, keel of the vessel; G, guide for the after-part of the keel; *p*, rack-pall; R, R, inclined plane, road, or platform, laid nearly with the same slope as the slips commonly used for building ships; fig. 1, plan of the slip and carriage. Fig. 2, side view of the ship. Fig. 3, stern view. Fig. 4, head view.









At Stobcross, a little below the new Quay on the Clyde, at Glascow, there is a slip on Morton's principle, but differing a little in the application. The vessel is there made to rest on the bilge, or under part of the bottom, instead of the keel, as in the above plan; by this means she requires less water to raise her on the carriage, as the groove between the iron rail-ways admits the keel, and allows it to move up and down freely, without requiring any support. The carriage consists of *two* separate beams resting on the rail-ways, without any intermediate keel-beam or cross pieces to connect them; to the ends of both are attached two connected series of iron rods, and two chains by which they are drawn up the inclined plane.

SLIPS, in Gardening, such portions of plants as are slipped off from their parent stems for planting out as sets.

SLOATH, or Sloth, the name of an animal remarkable for the slowness of its motion, whence its appellation. Of this animal there are three species. It is about the size of a fox, and is a native of South America, and of Ceylon in India. It requires three or four days to ascend a tree and descend from it; and on level ground, about fifty paces is a day's journey: its food is fruit, and the leaves of trees.

SLOE, *Prunus Sylvestris*, the English name for the wild plum. The juice expressed from this fruit while unripe, and inspissated by a gentle heat to dryness, is called German acacia. The bark both of the branches and roots, in intermittent fevers, is said to be little inferior to the Peruvian bark. The flowers made into a syrup and sweetened with sugar, is a good purgative for children. Tea is frequently adulterated with the leaves.

SLOOP, in Naval affairs, a small vessel furnished with one mast, the main-sail of which is attached to a gaff above, to the mast on its foremost edge, and to a boom below; it differs from a cutter by having a fixed steering bow-sprit, and a jib-stay; the sails also are less in proportion to the size of the vessel. Sloops of war are vessels commanded by officers of a middle rank between a lieutenant and a post-captain; these are styled masters and commanders. They carry from ten to eighteen guns, and are variously rigged, as ships, brigs, schooners, and sometimes cutters.

SLOPS, a name given to clothes for seamen.

SLOWWORM, a species of innoxious serpent, sometimes called the *blind worm*, and sometimes the *deaf adder*.

SLUG, in Gardening, a destructive kind of snail, eating off the leaves and buds of tender plants. There are various kinds, but all are highly mischievous to the gardener and farmer.

SLUICE, in Hydraulics, a frame of timber, stone, earth, &c. serving to retain and raise the water of the sea, a river, &c. and on occasion to let it pass.

Sluice, Self-Acting, *for Mills, or an Hydraulic Apparatus, for regulating the Supply of Water to Mills, by Mr. Robert Thom, of Rothesay Mills, near Glasgow.**—The drawings, in the Plate, exhibit no less than five distinct and separate operations; that is, each figure in the drawing is a complete apparatus of itself, applicable to different purposes, or under different circumstances, from any of the other drawings. The apparaatus, fig. 10, which, on account of the variety of operations it has to perform, appears more complicated than any of the others, is, notwithstanding, very simple when executed on a large scale. The advantages derived from the adoption of these inventions are many; as they relieve us from all anxiety and care respecting the waste of water, and the damages done to banks and other grounds by its overflow; and the exact quantity of water required by the works is always sent down, and no more; two steam-engines of thirty-horse power have been superseded at Edinburgh by their adoption; the yearly saving thereby is above six hundred pounds sterling.

*Explanation of the Plate.*—The lever sluice, fig. 1. This sluice, when placed on a reservoir that supplies any canal, mill, or other work, with water, (where the aqueduct between the reservoir and such work is on a level,) will always open of its own accord, and let down the quantity of water wanted by such work, and no more; that is, when water is wanted it will open, and when not wanted it will shut; so that it not only supersedes the water-man, but saves a great deal of water. A B, a tunnel through which the water passes from the dam to C D, the aqueduct that carries the water to the mills. E, a float that rises and falls with the water in the aqueduct. F, an aperture in the mouth of the tunnel. G, the self-acting sluice that opens and shuts aperture F. H I, a lever which turns upon fulcrum K, and is connected at one end with sluice G, and at the other with float E. The sluice G is here represented open, as when the mills are going, but when the sluice is shut that lets the water on the mill wheel, the water in the aqueduct rises, and with it float E, which raises the end I, and lowers the end H of the lever H I, and shuts sluice G. When the water is again let upon the wheel, the surface of the aqueduct falls, and with it the float, which opens sluice G as before. Upon the lever H I there is another small lever L M, which turns upon fulcrum M, and has the weight N suspended to the other end L. In the ordinary working of the apparatus this lever is quite stationary, and produces no effect whatever; but during floods, the aqueduct is swelled by streams that run into it between the reservoir and the mills, and when this happens when the mills are not at work, the water, by pressing up one end of the lever when the other cannot get down, would strain or break the apparatus. But, in such cases, the extra pressure raises the small lever, which takes all strain off the other parts; that is, the weight M requires more force to lift it than is required to shut the sluice; and therefore will not move till that takes place: but when the extra strain is continued after the sluice is shut, the lever and weight then rise with the float. The dimensions of the float are nineteen feet square by seven inches deep; the lever is twenty-seven feet long, being twice the length between the fulcrum and the sluice, that it is between the fulcrum and the float. The sluice is three feet three inches long, and fifteen inches deep; but it requires to be raised only seven inches (when the water in front is three feet high) to pass as much water as gives a power of forty horses to a water wheel, the fall there being twenty feet. To determine the proper dimensions of the float and relative lengths of the ends of the lever, it was necessary to ascertain how far the sluice required to be raised, to pass the quantity of water wanted; and also how far the water in the aqueduet might be raised above the height required to supply the works: the first was found to be seven inches, and the last only four inches. The end of the lever connected with

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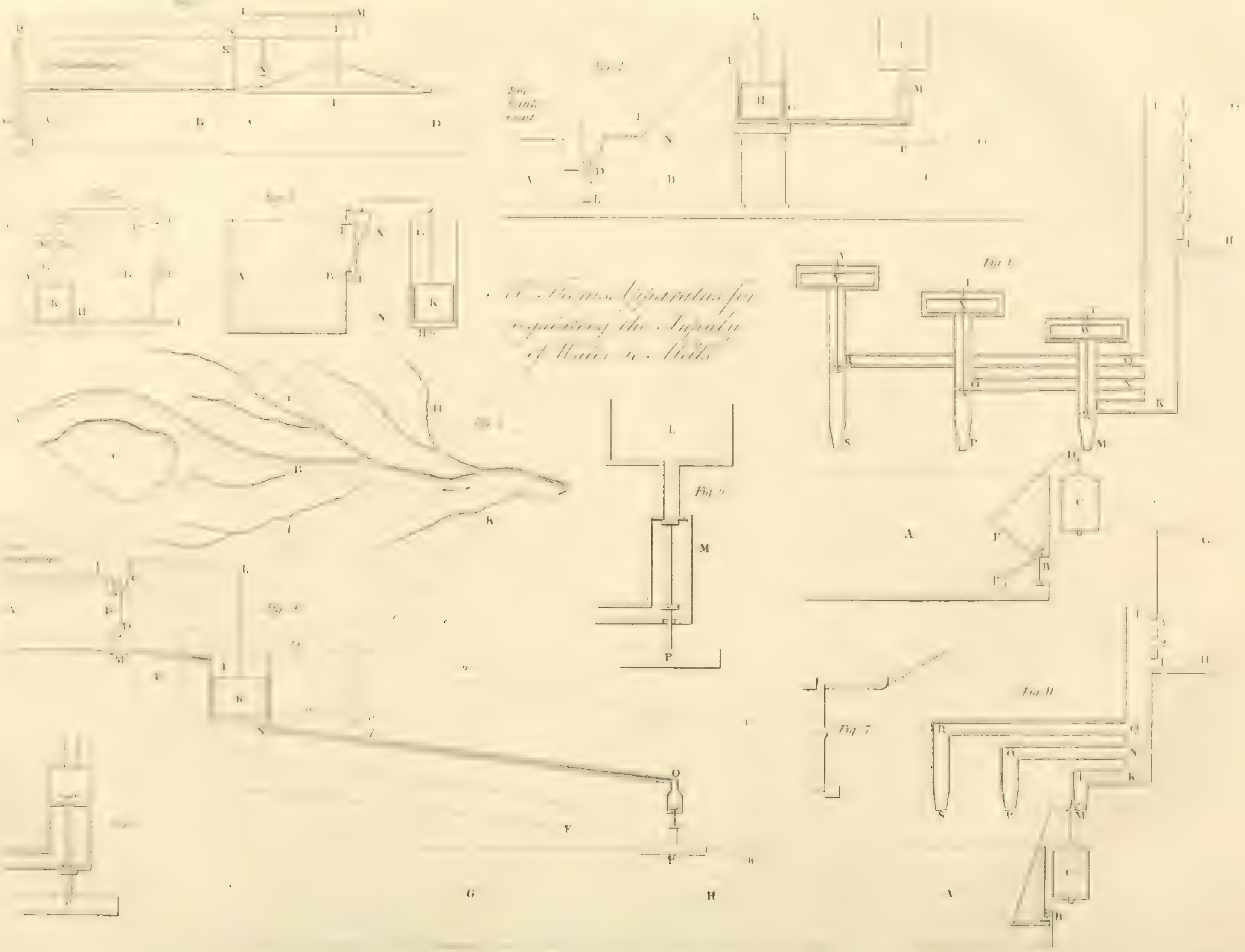
* From the Transactions of the Society of Arts, &c. vol. xl.—The Society presented their large Silver Medal to Mr. Thom for this communication.

## SLUICE



Mr. Brown's Apparatus for regulating the Supply of Water to Mills.

the float was made, therefore, only half the length of the end connected with the sluice; and the float was made of such dimensions, that, when sunk half an inch in water, the weight of water thereby displaced was equal to twice the weight required to shut the sluice with an equal lever. When, therefore, the water in the aqueduct rises upon the float half an inch higher than it sinks by its own weight, the sluice begins to move; and by the time the water rises other three and a half inches, the sluice is of course seven inches down, or shut. This apparatus has now been working at Rothesay five years.

The water sluice, fig. 2. This sluice, when placed upon any river, canal, reservoir, or collection of water, prevents the water within from rising above the height we choose to assign to it; for whenever it rises to that height, the sluice opens, and passes the extra water; and whenever that extra water is passed, it shuts again; so that whilst it saves the banks at all times from damage by overflow, it never wastes any water we wish to retain. A B part of a canal, river, stream, or collection of water. C D high water mark, or the greatest height to which the water is allowed to rise. E F a sluice, or folding-dam, which turns on pivots at F. G a hollow cylinder, having a small aperture in its bottom, from which proceeds the pipe H I. K another cylinder, water-proof, that moves up and down within the former cylinder. L a pulley, over which passes a chain attached to the sluice and to the cylinder K. When the water in the canal or river rises to the line C D, it passes into cylinder G at the small holes M M, and this lessens the weight of cylinder K so much, that the pressure of the water in front of sluice E F throws it open. When the water subsides, and no longer runs in at the small holes in cylinder G, that cylinder is emptied by the small pipe H I at its bottom, which is always open, and then the weight of cylinder K shuts the sluice as before. An apparatus of this kind was first erected at Rothesay in 1817. The dimensions of one of these are, K, two feet diameter and two feet deep, over all: weight 500*lbs.* G, five feet ten inches deep and two feet one inch diameter inside. E F, four feet long and two feet deep, but the cylinders are powerful enough to work the sluice six inches deeper. This sluice may be made with pivots to turn at the top, bottom, or middle: it may also be placed at the surface or bottom of the water, or any intermediate space, or right below, as suits the particular case; the cylinders may also be placed as shewn in fig. 3, without the reservoir; that is, on the outside, or behind the dam or embankment, by having a pipe N N to communicate between the upper part of the canal or reservoir and the cylinder. In this case, the chain passes over two pulleys, and is attached to an arm projecting from the back of the sluice. By adopting this principle, a self-acting dam may be raised in any river or stream, up to high-water mark, by which means a considerable reservoir will be obtained, whilst during floods the dam will fold down, and no new ground be overflowed. In lawns or pleasure-grounds, through which streams or rivulets flow, these sluices might be applied to advantage; for, by placing one on the bank of each pond, the water within would always be kept at the same height, let the weather be wet or dry; and, therefore, flowers and shrubs might be planted close to the water's edge, or in it, as best suits their respective habits, and their position with regard to water would always be the same.

The double-valve sluice, fig. 4. This sluice answers the same end as the lever sluice, but is more applicable in cases where the reservoir is deep, and the embankment consequently large. It also answers the purpose of the waster sluice, as it opens and passes the extra water, whenever it rises in the reservoir the least above the height assigned, and of course supersedes a by-waste. In making hydraulic experiments, this sluice will also be found of considerable importance, as, by keeping the cistern from which we draw the water for the experiments always exactly at the same height, it will not only save intricate calculations, but make the result on the whole more correct. A, part of the tunnel through which the water flows from the reservoir to B C, the aqueduct that conveys the water to the mills. D E a sluice that turns upon pivots at D. F G a hollow cylinder; H another cylinder, water-proof, of rather less specific gravity than water, and which moves up and down freely in cylinder F G: a chain, one end of which is fixed to an arm attached to sluice D E, and the other to cylinder H, passes over pulleys I and K; L a cistern always full of water, being supplied by a spring; G M a pipe that communicates between cistern L and cylinder F G; N O the required level of the water in aqueduct B C; P a float which rises and falls with the water in aqueduct B C: attached to this float is a spindle carrying two valves, which by the descent of the float close the aperture in the lower end of pipe M, and open the communication between M and the cistern L. When the float P, and consequently the attached valves, rise, indicating a sufficiency of water in B C, the water escapes from the cylinder F G, because the lower aperture in M is opened, and the upper, which communicates immediately with the cistern L, is closed; as shewn on a larger scale, fig. 6. The sluice D E, fig. 4, is represented shut, cylinder F G empty, cylinder H at the bottom of F G, and the water in the aqueduct at its greatest height. Suppose now, water to be drawn from the aqueduct for any purpose, the float P will fall with the water, and with it the valves. The water now flowing into F G from L will be retained; H will be deprived of its weight, and consequently of its action on sluice D E, which will then yield to the pressure of the water in the reservoir, and pass the requisite quantity, till the float P rising to its former level, opens the lower valve, and shuts off the communication between L and M; the cylinder F G then empties itself, and the weight H closes the sluice. In order to make this sluice operate also as a waster sluice, a tube is made to communicate between the reservoir and cylinder F G; this tube, which must necessarily supply water to F G faster than it can escape by the valve in the lower end of M, enters the reservoir at the height to which we wish to limit the rise of the water, and whenever it rises so as to flow into this tube, the cylinder F G is filled, and the sluice D E opens, and passes the extra water so long as the supply continues through the tube to the cylinder F G; when that ceases by the subsiding of the water in the reservoir to its limited height, the sluice D E shuts as before. The axis of motion of this sluice, instead of being placed at the top, may be placed a little above its centre of pressure, as shewn in fig. 7. In this case, the whole of the operations before described will be reversed: the weight of cylinder H will tend to open the sluice, and the pressure of water in the reservoir to shut it; the rise of the float P, instead of opening the lower aperture of M, will close it, and open the communication with the cistern L, as shewn in fig. 8, the consequence will be, that the cylinder H will be deprived of its weight, and the sluice will be closed by the pressure of the water in the reservoir. In this case, the axis of motion is placed just so far above its centre of pressure as to allow the extra pressure below to overcome the friction, and shut the sluice when cylinder H is floated: this cylinder need only be heavy enough to overcome twice the friction, in order to open the sluice when the water is drawn from cylinder F G; I have found the friction in this case to be less than one-fiftieth of the weight of the column of water pressing upon the sluice; but to guard against contingencies, the machine is made powerful enough to act, although the friction were to become one-tenth, which from the nature of things is more than it can ever be. An apparatus on this construction was erected at Rothesay, in 1819, and has been in constant use ever since.

The single-valve sluice, fig. 9. The construction of this sluice is nearly the same as the last, only it is applicable in cases where the reservoir is on high grounds above the works requiring the water; and where, of course, the water passes down a declivity. A B part of the tunnel of a reservoir; C D a sluice that turns upon pivots at C; E F the rivulet that carries the water from the reservoir down to G H, part of a level canal or aqueduct. I is a hollow cylinder; K another cylinder, water-proof, of rather less specific gravity than water, which moves freely up and down within cylinder I; L a pulley, over which passes a chain attached at one end to the sluice, and at the other to the cylinder K; M, a small cistern kept always full of water, either by a small hole below the sluice, or by the waste from the sluice; a small pipe communicates between this cistern and the upper part of cylinder I; N O, another small pipe, communicating under ground between cylinder I and a valve at the lower end of O, which is closed by the descent of the float P; the float is placed within a small pool of water on the same level as, and communicating with, the canal. The water in the canal is represented as at its greatest height, the valve opened by the float P, the cylinder I empty, because the valve at O passes the water faster than it is supplied from the cistern M; the cylinder K is consequently at the bottom of I, and the sluice is closed. When the surface of the water falls in the canal, the float P falls with it, the valve at O is closed, the cylinder I is filled, and K floated, the sluice CD opens by the pressure in the reservoir, and supplies water till the canal GH acquires its proper height. The mode of producing this effect may be varied, as in the last instance, by hanging the sluice on pivots a little above the centre of pressure, so that it shall be kept closed by the weight of the water in the reservoir, and opened by the descent of cylinder K; the valve at O will then require to be shut by the ascent of the float P. It is of no consequence, therefore, in regard to regulating the supply of water, how far the reservoir is from, or how high above, the level of the works requiring the water, save that the length of the pipe NO must correspond with the distance, and its strength with the height or pressure of the water; it is necessary, however, that the bore of this pipe should be small, particularly where its length is considerable, in order that the sluice may open or shut in a short time after the valve at O opens or shuts, and at the same time require only a small supply of water for cistern M, as that supply must always flow, whether it be otherwise needed or not. Suppose, therefore, the opening into pipe NO from I to be only half an inch bore, and that the valve at O is shut, it is evident when that pipe is empty, that the sluice CD will not open (or shut, if being on pivots placed just above the centre of pressure) till both the pipe NO and cylinder I be filled; and that the smaller the bore of that pipe, the sooner will it be filled. The time, therefore, that sluice CD takes to open (or shut, as the case may be) after the valve at O shuts, will always be the same that the pipe NO and cylinder I take to fill; and to make sluice CD take an equal time to shut (or open, as the case may be) after the valve at O opens, the aperture of that valve must be such as to take an equal length of time to run off the water to the bottom of cylinder I, (while the water is still flowing from cistern M,) as the pipe from cistern M takes to fill both cylinder I and pipe NO, when the valve at O is shut.

The chain sluice. This apparatus answers exactly the same purpose as the last, but the construction is somewhat different; that difference is described by dotted lines in connexion with the last figure, of which let all the parts be supposed to remain except the pipe from the cistern M, the pipe NO, and the float P. A, pipe *m* communicates between cistern M and the upper end of cylinder *n o*, from the lower end of which proceeds a pipe *p* connected with the bottom of cylinder I; an aperture in the lower extremity of *no* is supplied with a valve opening downwards loaded with a weight *q*, and attached to a rod suspended from the end of a lever *r s*, moving on a fulcrum at *t*; a chain passing round two pulleys *u* and *v* connects the other end of this lever with a float *w*, of sufficient weight to overcome the loaded valve *q*. To apply this apparatus where the sluice is hung on pivots just above the centre of pressure, no change is required but that of making the valve *q* open upwards. This construction may, perhaps, be adopted with advantage on account of its cheapness, where the reservoir is very near the level canal, but a considerable height above it; as a brass wire one-tenth of an inch diameter will be strong enough for the chain where the distance is short, it having in any case little more to lift than twice its own weight; the former method using the pipe NO instead of the chain, seems better adapted to general purposes.

The double weather sluice, fig. 10. This apparatus is designed for what are generally called compensation reservoirs, where we are only allowed to retain the surplus water of floods, the rivulet or stream being allowed to flow at all other times the same as if no reservoir were there. The usual way of doing this, which may be understood by reference to fig. 5, is to cut an aqueduct, AFB, round the reservoir C, along which all the water of the stream is carried past the reservoir, except during floods, when a part runs over at the by-wash F into the reservoir. But before any part is thus allowed to run over, the proprietors below at Z must have all they need; and then the rise that sends part into the reservoir, sends also more down the aqueduct; this additional part sent down is therefore lost. But the same rains that swell the streams above the reservoir, also swell the streams GHI and K between the reservoir and place below at Z, where the greatest quantity of water may be needed; all this additional water from the streams below, is therefore also lost. By adopting this apparatus, all that waste is saved, or retained in the reservoir; so that whilst the proprietors below have, in all ordinary times, the same water as if no reservoir had been made, we retain in the reservoir, during floods, all the water not then needed below. A is a basin of water, behind a reservoir, in which the water is always kept at the same level by the apparatus, fig. 4. B, one of a number of sluices of the same kind on that basin. C, a can, open at the top, and having a very small aperture in the bottom; a chain passes over pulley D, having one end fixed to the arm E, attached to sluice B, and the other to can C. F, a weight that keeps the sluice B always shut, when the can C is empty: when that can is full of water, it lifts the weight F, and opens the sluice. GH, a section of that part of the rivulet immediately before it falls into the reservoir. IKL, a pipe, which communicates between the rivulet at GH, and the can C. When the water in the rivulet GH is so low only as to flow through aperture 1, then, all that water passing down pipe IKL, flows out at M into can C, which being thus filled with water, opens sluice B, and passes as much water as the rivulet then brings into the reservoir. But when the rivulet swells so as to flow out at aperture 2, then the opening at M not being able to pass the whole, the water rises in pipe IK, and passes along pipe NOP, and falling into another can,* opens a second sluice, which, with the first, passes as much water as the rivulet then brings into the reservoir. When the water in the rivulet rises so as to flow out at aperture 3, it rises also in IK, and passing along pipe QRS, flows out at S into a third can, and opens a third sluice; and these three pass as much water as the rivulet then brings, and which is here supposed to be the greatest quantity wanted at the place Z, fig. 5. Suppose now the flood should still continue to increase; then the streams and surface water between the reservoir and Z will increase the rivulet at Z, as well as the higher streams increase it at GH; but there was previously enough of water at Z; when, therefore, the rivulet rises so as to flow out at aperture 4, the water will rise also in the vertical tubes M, P, and S, which are respectively surmounted with wide hollow cylinders, T, U, and V, containing the water-pipe floats W, X, and Y. The water first rises to float W, which it lifts, and thereby shuts valve L: the water in can C then passes out at the small opening in its bottom, and the weight F shuts sluice B, which stops as much water in the reservoir as the streams below have increased. When the water rises in the rivulet so as to flow out at aperture 5, it rises also in the tubes till it lift float X, which shuts another sluice. When the rivulet rises till the water flows out at aperture 6, it raises float Y, and shuts the third or last sluice, the flood being now supposed so great, that the streams below the reservoir are sufficient for the supply at *z*. When the streams begin to fall, the rivulet at GH will also fall, and when the water ceases to flow into aperture 6, the water falls so far in the tubes as to let down float Y, and open one sluice; when it ceases to flow out at aperture 5, the float X falls, and a second sluice opens; when it ceases to flow out at aperture 4, the third sluice opens, which, with the other two, passes all the water that the rivulet is then bringing into the reservoir. Should the rivulet continue to fall so as not to flow out at aperture 3, then the water ceases to flow along QR, and one sluice shuts; should it fall below aperture 2, the water also ceases to flow along NO, and a second sluice shuts; should the rivulet become quite dry, then the third or last sluice shuts. Any number of sluices may be used, as found necessary: and in this way the same quantity of water will always run in the rivulet at Z, as if no reservoir had been placed in the rivulet above; except during floods, when all the water not needed at Z, would be retained in that reservoir. Besides the immense quantity of water thus gained during floods, the expense of cutting an aqueduct round the reservoir is also saved, nor is any by-wash necessary, as the main sluice on the reservoir that regulates the height of the water in the basin A, acts also as a water-sluice when necessary. When it is necessary to supply any fixed quantity of water from the reservoir, we have only to make an aperture in the basin of the proper size, and, as the water there stands always at the same height, the supply will always be the same.

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* The first can only is shewn in the engraving, but the relative situations of the other cans with respect to the pipes P and S, may be easily understood.

The single weather sluice, fig. 11. One of the applications of this apparatus is, to give, at all times, an equal supply of water to any work, situated like Z, in the last case, where the reservoir is at a great distance from the work, and where it might be inconvenient or expensive to lay a pipe between them as in fig. 4. The description of the last figure applies also to this, only when the can C is filled with water, it shuts sluice BC, instead of opening it as in that figure. In very dry weather, when all the streams between the reservoir and the work are dried up, then it requires all the sluices at the reservoir to be open, to give the necessary supply to the works, but when the streams begin to flow a little, one sluice at the reservoir shuts, by the water flowing through aperture 1 into can C; when they increase still further, the water flows out at aperture 2, and along pipe NO, and shuts a second sluice; should they still increase till the water flow out at aperture 3, the third or last sluice shuts, the streams of themselves being now equal to the supply required. As the streams again fall off, the sluices will open, one after another, so as to keep the supply of water at the work always equal. It is necessary, in this case, to have a small reservoir near the work, to contain the water that flows down at night, or when the work is standing; and then this apparatus will be a complete substitute for the last apparatus, fig. 10. The purpose, however, for which this apparatus was invented was different. Having occasion to cut an aqueduct round the bases of some hills, to collect water, and convey it to a reservoir at a considerable distance, I found that to make the aqueduct so large as to convey all the water during floods would be too expensive; it therefore occurred to me, that if a part of the water could be detained during floods, and brought away gradually afterwards, a much smaller (and of course much less expensive) aqueduct would answer the purpose; I therefore made a small reservoir at a convenient place, and contrived this sluice to shut during floods, and to open as they decreased; and this answered the purpose intended completely, and was the origin of all the weather-sluices.

SLUSS, SLUDGE, or *Slush*, a soft miry substance, serviceable in manuring land.

SMACK, a small vessel commonly rigged as a cutter, and used in the coasting and fishing trade, or as a tender in the king's service.

SMALL-POX, a highly infectious and formidable eruptive fever, which occurs in general but once to the same person. It is distinguished by the appearance of pustules on the third or fourth day of the fever. The face is sometimes dreadfully disfigured with the variolous corrosion. It is supposed to have existed in China and Hindostan several centuries before it was introduced into Europe. About the year 572 of the Christian era, it appeared at Mecca. From this place it was conveyed to Alexandria, and in the eighth century it was spread over France, Spain, and Italy, by the Saracens, in their progressive expeditions into the regions of the west.

SMALT, the last produce of cobalt, a kind of mineral matter, prepared and purified abroad, and brought hither sometimes in blue powder, and at other times in lumps. It is chiefly used with starch, and is generally known by the name of powder blue.

SMARTWEED, a troublesome weed, generally found in arable lands, and more commonly called arsesmart. Its juices have been known to remove warts, by frequently rubbing them with its green leaves a little bruised.

SMELL, SENSE OF. The sense of smell is very nearly allied to that of taste, and indeed many of those pleasurable sensations which are usually referred to the taste, as being received during the act of eating and swallowing, really belong to the smell. The organ of smell is a membrane or skin overspread with nerves, which line the internal cavity of the nostrils, and the surface and cavities of the bones which join the nostrils. This is affected both by the odorous particles which proceed from external substances through the nose, and by those that come from the substances which are eaten: for there is a communication between the nose and the back part of the mouth. The disagreeable sensations occasioned by smell assist us in the proper choice of food, and prompt us to avoid such noxious vapours as may render the air injurious to health or life. It appears also, that offensive odours in various circumstances, contribute to generate the sense of shame, decency, &c. The pleasures of smell have a direct connexion with those of taste; and in several instances, such is their mutual union and co-operation, that the association appears almost inseparable. The fragrance which arises from the various productions of nature, adds new charms to her landscapes; and the pleasing sensations which enhance our mental enjoyments when inhaling the grateful incense, live in our recollections, when the representations of them are again brought before us in poetry and painting.

SMELTING, in Metallurgy, the fusing or melting of the ores of metals, in order to separate the metalline part from the earthy, stony, and other parts.

SMITHERY, or SMITHING, a manual art by which an irregular lump of iron is wrought into any intended shape.

SMOCK, LADY'S, or *Bitter Cress, Cardamine Amara*, in Agriculture, a plant of the weed kind, found in coppices, and on the banks of rivers, which sheep are said sometimes to eat. Some think the common sort is useful in epilepsies.

SMOKE, a humid matter exhaled in form of vapour by the action of heat, either external or internal. It consists of palpable particles elevated by means of the rarefying heat, or by the force of the ascending current of air, from bodies exposed to heat. Sir Isaac Newton observes, that smoke ascends in chimneys by the impulse of the air in which it floats; for that air being rarefied by the fire underneath, hath its specific gravity diminished, and being thus determined to ascend, it carries up the smoke along with it. Smoke of fat unctuous wood, such as fir, beech, &c. makes what we call lamp black. Smoke arising from the combustion of vegetables, is a mixture of water, oil, volatile salts, and all the gaseous products which result from the combination of vital air with the several principles of the vegetable. In the Philosophical Transactions, we have the description of an engine invented by Mons. Dalesme, which consumes the smoke of all sorts of wood, leaving nothing to affect either the sight or smell. It consists of several iron hoops, four or five inches in diameter, which shut into one another, and is placed on a trivet, but its mode of operation we have not seen.

SMOKE *Sail*, a small sail, hoisted against the fore-mast when the ship rides head to wind, to give the smoke of the galley an opportunity of rising, and to prevent its being blown aft on to the quarter deck.

SMUGGLING, in civil economy, the importing contraband goods, or the selling of such as the law has made excisable, without paying the legal impost. Several severe laws have been enacted against this species of traffic, but no measures hitherto adopted have been able wholly to suppress the illicit trade. The preventive service holds it under the most powerful restraints.

SMUT, a disease in corn which destroys entirely the germ and substance of the grain.

SNAIL. *See* HELIX.

SNAKE in Zöology, a genus of serpents, the characters of which are, that they have abdominal and subcaudal scales. Of the snake tribes the species are vastly numerous, some of which are inoffensive, while others are dangerous in the highest degree. Those that live in warm climates sometimes grow to an enormous size, and many instances of their strength have been recorded, which appear almost incredible. In these sultry regions, their poison is also more acute than in other portions of the globe, but in general the largest have not been found the most venomous. Perhaps, of none is the poison more virulent than that of the rattlesnake.

SNAKE, *Sea*, a strange kind of fish, of the eel kind, said to reside in the northern seas, and to have been seen on the coasts of Norway, and on the shores of North America. The size and length of these creatures seem to be almost incredible. Some accounts represent them from fifty to seventy feet long, and others have extended their length to six hundred feet. There can be little doubt that some of these statements have been exaggerated, the calculations of length having been made in all cases without actual measurement. The evidences, however, in favour of such creatures actually existing, have of late been so numerous and convincing, that the fact seems to be placed beyond the reach of all reasonable suspicion.

SNAKE *Root*, *Serpentaria*, in Medicine, the root of a species of aristolochia. Prior to the discovery of America, only two kinds of serpentaria were known; but since that event, several others have been added, such as the Virginian, the Canadian, and the Brazilian. The snake-root of Virginia was esteemed by the Indians as a sovereign antidote against the bite of the rattlesnake. Some travellers assert, that the smell of this antidote drives the rattlesnake away, on which account the Indians, when travelling in dangerous places, tie a portion of snake-root to the end of their staff, to prevent being bitten. In a dried state it is imported into this country in bales, each containing from two to five hundred weight. The smell is aromatic, not unlike that of valerian; and the taste is warm, sharp, and bitter, somewhat resembling that of camphor. It is highly esteemed for various medical purposes.

SNAKE *Stone*, a species of shell, of a flattened spiral figure, containing many circumvolutions, exhibiting a distant resemblance to a snake coiled up, and in that state becoming petrified. These snake-stones, generally described as *ammonites*, are very numerous in various parts of the world, but the race of animals, of which these are the remains, is supposed long since to have become extinct.

SNAKE *Weed*, in Agriculture, a common grass, frequently found by the sides of roads, which, if cultivated, would produce seeds answering the same purposes as those of buck-wheat. It is annual, or at most biennial, in its growth.

SNAKE *Wood*, in the Materia Medica, is the wood or root of the tree which affords the *nux vomica*. It is brought from the East Indies under the name of *lignum colubrinum*, in pieces about the thickness of a man's arm, covered with a rusty-coloured bark, and is internally of a yellow colour, with whitish streaks. When rasped, this wood yields an agreeable smell, though it is somewhat faint, and, on being tasted, the flavour is bitter.

SNAKING, is the winding small ropes spirally round a large one, the former lying in the intervals between the strands of the latter, and is frequently termed WORMING, which article see.

SNAPDRAGON, in Botany, see ANTIRRHINUM. The smaller sort of snapdragon is a troublesome weed in corn fields.

SNATCHBLOCK, a block having an opening in one of its sides, wherein to fix the bight of a rope occasionally. This is by some termed a rouse-about block.

SNEEZING, in Medicine, *sternutatio*, a violent convulsive motion of the muscles of respiration, which is preceded by a deep inspiration that fills the lungs, and then forces the air violently through the nose, while the under jaw is at the same moment closed. The effort shakes the head, and the whole body. This convulsive sensation is always excited by some irritation affecting the inner membrane of the nose; the air, therefore, which in coughing is expelled through the mouth, is vehemently driven through the nose, for the purpose of expelling that irritation.

SNIPE *See* SCOLOPAX.

SOAL-FISH. *See* PLEURONECTES.

SNORING, in Medicine, a sound produced by sleeping persons, in particular positions, apparently occasioned by the vibrations of the palate, in a state of relaxation, when the respiration is performed by breathing through the mouth and nose at the same time.

SNOW, a well-known substance, formed by the freezing of the vapours in the atmosphere. It differs from hail and hoar-frost, in being as it were crystallized, which they are not. This appears on examining a flake of snow by a magnifying glass; when the whole of it will appear to be composed of fine shining spicula, diverging like rays from a centre. As the flakes fall down through the atmosphere, they are continually joined by more of these radiated spicula, and thus increase in bulk like the drops of rain, or hailstones.

The whiteness of snow is owing to the small particles into which it is divided: for ice when pounded will become equally white. According to Beccaria, clouds of snow differ in nothing from clouds of rain but in the circumstance of cold that freezes them. Were we to judge from appearances only, we might imagine that so far from being useful to the earth, the cold humility of snow would be detrimental to vegetation. But the experience or all ages asserts the contrary. Snow, particularly in those northern regions where the ground is covered with it for several months, is of service to the earth, by guarding the corn or other vegetables from the intenser cold of the air, and especially from the cold piercing winds. It has been a vulgar opinion, very generally received, that snow fertilizes the land on which it falls, more than rain, in consequence of the nitrous salts which it is supposed to acquire by freezing. But it appears from the experiments of Margraaf in the year 1731, that the chemical difference between rain and snow water is exceedingly small. —Different vegetables are able to preserve life under different degrees of cold, but all of them perish when the cold which reaches their roots is extreme. Providence has, therefore, in the coldest climates, provided a covering of snow for the roots of vegetables, by which they are protected from the influence of the atmospherical cold. The snow keeps in the internal heat of the earth which surrounds the roots of vegetables, and defends them from the cold of the atmosphere.

SNOW, a vessel equipped with two masts, resembling the main and fore masts of a ship, and a third small mast just abaft the main-mast, carrying a sail nearly similar to a ship's mizzen; the foot of this mast is fixed in a block of wood, or kind of step, upon the deck, and the head is attached to the after-part of the main-top. The sail is called a try-sail, and hence the mast is termed a try-sail mast. When sloops of war are rigged as snows, they are furnished with a strong rope called a horse, instead of the try-sail mast, the fore part of the sail being attached by rings to it. This is generally the largest of all two-masted vessels employed by Europeans, and is reckoned the most convenient for navigation.

SNOW *Bird*, in Ornithology, a bird that appears in Scotland in severe weather, and deep snows. It is sometimes called snow-flakes, and occasionally breeds in the Highlands, on the summits of the highest hills, but the greater part emigrate from the extreme north, and their appearance indicates a rigorous season.

SNOW *Drop*. *See* GALANTHUS.

SNOW *Grotto*, an excavation made by the waters on the side of Mount Etna, by making their way under the layers of lava, and by carrying away the bed of puzzolana below them. This place is used for a magazine of snow; for in Sicily at Naples, and particularly at Malta, they are obliged, for want of ice, to make use of snow for cooling their wine, sherbet, and other liquors, and for making sweetmeats. *See* RED SNOW.

SNOW *Plough*, a contrivance for the purpose of clearing the roads of snow. It has been long used in Sweden, and has of late years been introduced into this country. It consists of boards brought to a point in the front, which enters the snow, and spreads behind to any given width which may be required. In this manner it is driven forward through the snow by horses, and the snow is thrown off on each side somewhat like furrows by the plough used in agriculture.

SNOW *Stone*, in Natural History, a beautiful stone found in some parts of America. It is richly variegated, and when polished exhibits an appearance resembling snow falling in all its whiteness upon a jetty surface.

SNUFF, a preparation of tobacco, made by reducing it into a powder, fit to be taken in at the nose, to clear the head of pituita. Many other ingredients are mixed with the tobacco, to give the snuff a more agreeable scent. The sorts already in use are too numerous to be named, and every month furnishes new combinations, possessing virtues till then unknown.

SOAP, in domestic economy, a composition of caustic alkali, salt, and oil, or other grease. The earths, and the other metallic oxides, also combine with fat and oils, forming neutral compounds. The former have been called earthy, and the latter metallic soaps. Soaps in common use are made with the fixed alkalis, combined with different kinds of fat and oil. These are divided into two principal varieties, hard and soft, which, in their being manufactured, undergo distinct processes. There are few compounds in which the chemical art appears to greater advantage in common estimation, than in the formation of soap.

Soap refuse, and soap suds, and most kinds of soapy mixture, have been found to be highly valuable as manure, and great promoters of vegetation.

**Soap** *Stone*, a species of steatite. The name is derived from its colour, and from the peculiar unctuous sensation which it imparts to the feeling, which resembles that of white soap. It is sometimes striped and mottled with veins and spots of a dull purple. The only place in England where this stone is found, is at the Lizard, in Cornwall, connected with veins of serpentine, to which rock it seems nearly allied. It is much used in china manufactures.

**Soap** *Berry Tree*. The berries of this tree are about the size of a musket bullet, and are winged with leaves. The skin and pulp are used as soap without any mixture whatever, and, in the cleansing of linen, they are a valuable and cheap substitute; but being of an acid nature, the finer articles of dress rot much sooner than under common soap. These berries are much used by the negroes. They are also said to have many medicinal virtues.

**SOAPER'S** Waste. *See* Soap.

**SOAPY** Rock. *See* Soap *Stone*.

**SOCCAGE**, an ancient tenure, by which lands were held on condition of ploughing the lord's lands, and doing the other operations of husbandry, at their own charges.

**SOCCUS**, in Antiquity, a kind of high shoe reaching above the ankle, worn by comedians, as the cothurnus was by tragedians.

**SOCIETY**, an assemblage or union of several persons in the same place, for their mutual assistance, security, interest, or entertainment. For the origin of civilized society, various causes have been assigned. To investigate the numerous theories that have been presented to the public on this interesting topic, would be an almost endless task. It would be scarcely less difficult to enumerate and characterize the various societies that have sprung up in civilized states.

**SOCINIANS**, in Church History, a sect of Christians so called from their founder Faustus Socinus, a native of Sienna, in Italy: they ascribe proper divinity to the Father only.

**SOCK**, in Agriculture, the share of a plough, or that part which opens the land.

**SOCLE**, or **Zocle**, in Architecture, a flat square member under the bases of pedestals, statues, vases, &c. which it serves as a foot or stand.

**SOCO**, in Ornithology, a Brazilian bird of the heron kind, remarkable for the length of its neck, and its variegated colours.

**SOD**, in Agriculture, a portion of turf or sward, cut or dug up. It also signifies the soil or earth. The square pieces of surface turf and earth, that are cut up in forming embankments and earth fences, are likewise termed sods.

**SODA**. This is found to be compounded of oxygen and a metallic basis called sodium; but as it is found thus combined, and as it is only in this state of combination that it is of the smallest importance, it deserves to be specially noticed. It was formerly called mineral alkali, as it is found in mineral seams and crusts; also in very great abundance in certain lakes near Alexandria in Egypt, in the dry season, being brought thither by the water which enters from the neighbouring country during the overflow of the Nile, and precipitated by the evaporation of the sun during the dry season. Barilla is the impure soda obtained by burning the salsola soda and other plants near the sea. Kelp is still more impure, containing only a small portion of pure alkali. It is obtained by burning sea-weed. For the purposes of commerce, soda is obtained from common salt, or muriate of soda.

**SODALITE**, in Mineralogy, is a stone that derives its name from the large portion of mineral alkali that enters into its composition. Its colour is a bluish green.

**SODE-SHOOTS**, in Botany, is a name given by some to the tree whose inspissated juice is the gum tacamahacca of the shops.

**SODIUM**, in Chemistry, is a simple body, and a metal. This was discovered by Sir Humphrey Davy in the year 1807. A few days prior to this event he had ascertained, that potass was a compound of a peculiar metal combined with oxygen; and he now found, that soda consisted of a metallic substance combined with oxygen. He first produced it by exposing soda to the action of the galvanic battery. It is now produced by fusing soda or muriate of soda with potassium. The potassium combines with the oxygen in the soda, and with the chlorine in the salt, leaving pure sodium. The metal is white, resembling silver, and having the same metallic lustre.

**SOFA**, in the East, is a kind of alcove raised about six inches above the floor of the apartment in which it appears. With princes it is a place of state, where visitors of distinction are received. When this ceremony is omitted, it is considered as a mark of disrespect. Sofa, with us, is a piece of furniture that may be ranked among the refinements and luxuries of civilized life. It serves either as a seat or couch, on which the occupier may sit or stretch himself at ease. The frame is of timber, and extends about six feet in length, and is sufficiently wide to render the seat comfortable. Sofas are covered with cotton, hair cloth, damask, or more costly articles, and generally stuffed with horse hair, and furnished with moveable cushions; and sometimes with mattrasses formed of the same materials. The sopha has been immortalized by the poet Cowper in his "Task."

**SOFFITA**, in Architecture, any timber ceiling, formed of cross beams, or flying corniches, the square compartments or pannels of which are enriched with sculpture, painting, or gilding.

**SOFT Chalk**, a sort of fossil marl, which readily becomes blended with common vegetable mould, and therefore forms an excellent manure. It is chiefly valuable in lands that are stiff and unyielding.

**SOIL**, in Agriculture, is a general name applied to the surface of all sorts of land which will support vegetation. It is also more particularly applied to the fine powdery materials which have been gradually formed by time, from the various earthy and other bodies in nature, being ground down and incorporated with each other in divers states and proportions. It is therefore obvious that there must be great diversities of soil in different districts. The stratum which lies next below, is generally denominated the subsoil. Professor Davy, in an excellent paper on the analysis of soils, observes, that the substances which are found in soils are certain mixtures or combinations of some of the primitive earths, animal and vegetable matter in a decomposing state, certain saline compounds, and the oxide of iron.

**SOILING**, in Agriculture, the practice of supporting animals of various kinds, in the summer season, with green food of different sorts cut daily, and given to them in racks, in the houses, stalls, or yards, instead of sending them to the fields.

**SOLANUM**, in Botany, an ample genus, comprising various kinds of nightshade and other deadly plants.

**SOLDER**, **Sodder**, or **Soder**, a metallic or mineral composition used in soldering or joining other metals. Solders are made of gold, silver, copper, tin, bismuth, and lead, usually observing, that in the composition there shall be some of the metal that is to be soldered mixed with some higher and finer metals.

**SOLDERING**, the joining and fastening together of two pieces of the same metal, or two different metals, by the fusion and application of some metallic composition, on the extremities of metals to be joined.

**SOLDIER**, a military man, who voluntarily enlists to serve a prince or state for pay. The term includes officers of all ranks, as well as privates. The volunteer serves of his own accord without pay; the vassal is compelled to serve at his own expense; while the soldier, though a volunteer when he enters, is remunerated for his services, but is no longer free.

**SOLE of a Gun Port**, is the lower part of it, and is more properly called the port sill.

**Sole** *of the Rudder*, a piece of timber attached to the lower part of it, to render it nearly level with the false keel.

**SOLECISM**, in Grammar, a false manner of speaking, contrary the use of language and the use of grammar, either in respect of declension, conjugation, or syntax.

**SOLEN**, Razor Sheath, or *knife-handle shell*, a genus belonging to the class of vermes, and order of testacea. The animal is an asceidia. The shell is a bivalve, oblong, and opening at both sides; the hinge has a tooth shaped like an awl, bent back, often double, not inserted into the opposite shell; the rim at the sides somewhat worn away, and has a horny cartilaginous hinge.

**SOLICITOR**, a person employed to take care of and manage suits depending in the courts of equity.

**SOLID.** Geometricians define a solid to be the third species of magnitude, or that which has three dimensions, *viz.* length, breadth, and thickness or depth. Geometric solids are the regular figures cut in wood or crystal.

**SOLIDITY**, is that property of matter by which it excludes all other bodies from the place which itself possesses.

**SOLO**, in Music, a term used in pieces consisting of several parts, to mark those that are to perform alone.

**SOLSTICE**, in Astronomy, is the time when the sun is at the greatest distance from the equator, and is thus called, because he then appears to be stationary in the zodiac; which arises from the obliquity of our sphere. There are two solstices in the year, generally denominated the summer and the winter solstice. The former is on the 21st of June, when the sun is in the tropic of Cancer, and all the inhabitants of the northern hemisphere have their longest day: the latter is on the 21st of December, when the sun enters the first degree of Capricorn, and makes the shortest day to the above inhabitants. To all those who live on opposite sides of the equator, the longest and shortest days, and the summer and winter seasons, stand reversed.

**SOLUTION**, in Chemistry, denotes an intimate mixture or perfect union of solid bodies with fluids, so as seemingly to form one homogeneous liquor.

**SOMATOLOGY**, comprehends our knowledge of bodies, or external substances. The properties of bodies, says Leslie, are detected by the senses, either from immediate observation, or through the application of experiment, and the aid of instruments. The more obvious properties are revealed to us merely by touch or sight; but the penetration of the telescope has enabled us to survey vast systems of worlds, dispersed through the remotest heavens; while the opposite power of the microscope has brought within our view, from the very verge of existence, a miniature creation of organized beings. Again, the most careless observer can hardly have omitted to perceive that the air is a compressible fluid, while it requires a very delicate experiment to discover the same property in water. The properties of body are either essential and permanent, or they are contingent, and susceptible of change or variation. Body is essentially, 1. extended; 2. figured; 3. impenetrable; 4. divisible; 5. porous; 6. contractile, or distensible.

**SOMMITE**, a mineral which is found in small crystals in the lava on the sides of mount Somma, which is a part of Vesuvius.

**SOMNAMBULISM**, sometimes called Noctambulism, or Sleepwalking. In this singular condition of the body, a person performs many voluntary actions, implying a certain degree of perception of the presence of external objects, but without any consciousness while the actions are performed, and without any recollection of them when consciousness returns. Of this very remarkable phenomenon many very singular accounts have been recorded, but the physical causes of sleepwalking remain yet in a great measure to be explored. Dugald Stewart, in his Elements of the Philosophy of the Human Mind, has the following observations in reference to Somnambulism: " There are many cases in which sleep seems to be partial; that is, when the mind loses its influence over some powers, and retains it over others. In the case of Somnambulism, it retains its power over the limbs, but it possesses no influence over its own thoughts, and scarcely any over the body, excepting those particular members of it which are employed in walking." Some, indeed, have doubted whether the state in which these persons are, who thus walk and act, can justly be denominated sleep. Dr. Cleghorn has pointed out several particulars in which this condition differs from sleep; and Dr. Darwin, in his Zoonomia, considers it as belonging to *reverie*, or as approximating to epilepsy, or catalepsy, rather than to real sleep. It must, however, be acknowledged, that these are but mere opinions and theories, totally unsupported by any thing conclusive, and nearly all we know with certainty is, that the facts connected with Somnambulism are too obvious to be denied, while their causes have hitherto in a great degree eluded all research.

**SONATA**, in Music, a piece or composition intended to be performed by instruments only.

**SONCHUS**, in Botany, the *Sow Thistle*, so called because it is a plant of which swine are remarkably fond.

**SONG**, in Poetry, a little composition, consisting of easy and natural verses set to a tune in order to be sung.

**Song** of *Birds*, has been defined to be a succession of three or more different notes, which are continued without interruption, during the same interval, with a musical bar of four crotchets in an adagio movement, or whilst a pendulum swings four seconds.

**SONNA**, a book containing Mahometan traditions, which all true Mussulmen are required to believe, though they be not included in the Koran, to which the Sonna is considered as a supplement.

**SOOT**, a substance deposited from the flame of burning vegetables.

**SOPHI**, or Sofi, a title of quality given to the emperor of Persia, which signifies wise, or sage, or philosopher.

**SOPHISM**, in Logic, &c. an argument which carries much of the appearance of truth, and yet leads to an error.

**SORCERY**, the crime of witchcraft, or divination, by the assistance of evil spirits.

**SOREX**, Shrew, a genus of quadrupeds of the order feræ. The generic character is, front teeth in the upper jaw two, long, bifid; in the lower, two or four, the intermediate ones shorter; canine teeth, several on each side; grinders cuspidated.

**SORTES**, in Antiquity, a method of deciding difficult cases by lots, dice, or the drawing of tickets.

**SOUL**, the spirit of man, which, in his present state, is adapted to the organization of his body, but which is capable of subsisting when it becomes disembodied. The word *soul* is understood in several other senses.

**SOUND**, on the coast of Norway in particular, is used for any opening of a river, or any gulf, or deep inlet of the sea, in the same sense as " deep" on the coast of Germany. In other parts it is more usually understood of a passage between the main land to which it is contiguous, and some island, which together form a strait or passage within such lands.

**SOUND**, or Hearing, sense of. The external air collects and modifies sounds; and by a long channel communicates them to the internal ear; this consists, in the first place, of what is called the drum of the ear, which is a small cavity, closed towards the opening of the ear by a delicate membrane. In the drum are three or four very small bones, furnished with muscles and joints. From the drum are several openings, one of which is to the mouth; the others communicate into the different recesses of the ear, One of these leads into the labyrinth, which consists first of a small irregular cavity, next of three semicircular canals, and lastly of a winding spiral canal, not unlike some sea shells. All these parts of the cavity are lined with a very delicate membrane, and filled with a watery fluid, which conveys to the portions of the nerve in contact with it, the vibrations received from the membrane which separates the labyrinth from the drum of the ear. The vibrations of the air act upon the drum, and thus set in motion the series of small bones in the cavity of the drum; these communicate the vibrations to the membrane which separates the drum from the labyrinth, and this (as before mentioned) produces vibrations in the watery fluid in the several parts of the labyrinth, and conveys to the nervous branches, which line the labyrinth, the vibrations originally produced on the drum. The mechanism is complicated, but what we understand must increase our reverential admiration of the skill which produced it. To illustrate the cause of sound, it is to be observed, 1st. That a motion is necessary in the sonorous body, for the production of sound. 2dly. That this motion first exists in the small and insensible parts of the sonorous bodies, and is excited in them by their mutual collision against each other, which produces the tremulous motion so observable in bodies that have a clear sound, as bells, musical chords, &c. 3dly. That this motion is communicated to, or produces a like motion in, the air, or such parts of it as are fit to produce and propagate it. Lastly, that this motion must be communicated to those parts that are the proper and immediate instruments of hearing. The sonorous body having made its impression on the contiguous air, that impression is propagated from one particle to another, according to the laws of pneumatics. Sound is conveyed through air with great rapidity. The motion of sound through the air is at the rate of about 13 miles in an hour.

**SOUND, Velocity of.** By Dr. Olinthus Gregory. (Abstracted from a paper by Dr. G. in the Transactions of the Cambridge Philosophical Society for 1824.) The results of the experiments hitherto made to determine the velocity of sound present an extraordinary discrepancy; thus,

| | Feet per second. | | Feet per second. |
|---|---|---|---|
| Mr. Roberts assigns a velocity of ........ | 1300 | Cassini de Thiery.... | 1107 |
| Mr. Boyle ............ | 1200 | Meger .............. | 1105 |
| Mr. Walker and Duhamel .............. | 1338 | Derham ............ | 1142 |
| Mersenne ............ | 1474 | Muller ............ | 1109 |
| The Florence Academy . | 1148 | Picket ............ | 1130 |
| | | Arrago ............ | 1106-32 |

A series of experiments undertaken by Dr. Gregory produced the following results:

| Velocity of sound. | Feet. | Velocity of sound. | Feet. |
|---|---|---|---|
| Fahr. therm. 27° . . | 1094·2 | Fahr. therm. 60° . . | 1112 |
| Ditto . 33 . . | $1099\frac{1}{6}$ | Ditto . 64 . | $1114\frac{3}{7}$<br>1116 |
| Ditto . 35 . . | 1102 | | |
| Ditto . 45 . . | $1107\frac{2}{3}$ | Ditto . 66 . | 1116<br>1117 |
| Ditto . 59 . . | $1109\frac{1}{4}$ | | |

Of these results, some have been obtained in the day-time, others in the night; some when the sound has been transmitted over the surface of the earth, others when it has been transmitted over the surface of water; some are the result of direct sound, others of both direct and reflected sound; some from the report of cannons, others of muskets, others from the sound of bells. Were these the only experiments (says Dr. G.) on the subject that had ever been made, I should not regard them sufficiently extensive to justify me in deducing from them even an approximative rule. But as they have beer made with great care, I may at least venture to present a rule, which, while it includes, with only slight discrepancies, all the preceding results, is simple enough to be easily recollected by practical men; and may, perhaps, be employed in our own climate. It is this:

At the temperature of freezing, 33°, the velocity of sound is 1100 feet per second.

$$\left.\begin{array}{l}\text{For lower temperatures deduct}\\\text{For higher temperatures add}\end{array}\right\}\text{ half a foot.}$$

$$\left.\begin{array}{l}\text{From the 1100}\\\text{to the 1100}\end{array}\right\}\text{ for every degree of difference from } 33^\circ \text{ on}$$

Fahr. therm. the result will shew the velocity of sound, very nearly, at all such temperatures.

Thus, at the temperature of 50°, the velocity of sound is $1100 \times \frac{1}{2}(50-33) = 1108\frac{1}{2}$ feet.

At temperature 60°, it is $1100 + \frac{1}{2}(60-33) = 1113\frac{1}{2}$ feet; agreeing with the experimental result quite within the limits of a practical rule.

The above practical rule, so far as it may be entitled to confidence, may be useful, 1st, to the military man, in determining the distance of an enemy's camp, of a fortress, a battery, &c.; 2nd, to the sailor, in determining the distance of another ship, &c.; 3rd, to the landsurveyor, in ascertaining the length of base lines, &c. in conducting the survey of a lordship or county; 4th, to the philosophic observer, in appreciating the distances of thunder clouds during a storm. Yet in either of these applications, the rule must be regarded as approximative only; because few practical men can be expected to possess a time-measurer for less intervals than tenths of seconds, if, indeed, so small: and an error of a tenth of a second will occasion a mistake of from 37 to 40 yards in the estimate of the distance. Beyond this, however, the error need scarcely ever extend; because a mean of five or six careful experiments will usually give the interval to a degree of correctness far within the limits just specified. Indeed, an error of from 30 to 40 yards in a distance of three or four miles, will, on most occasions, where such approximative estimates are required, be of but small consequence. When the distance exceeds four miles, this method of approximating to it can only be employed under favourable circumstances of a very quiescent atmosphere, &c. Combining the results of experiments here recorded with those which have been formerly deduced by Derham and others, we may, I think, conclude unhesitatingly, 1st, That sound moves uniformly, at least, in a horizontal direction, or one that does not deviate greatly from horizontality. 2nd, That the difference in intensity of a sound makes no appreciable difference in its velocity.* 3rd, Nor, consequently, does a difference in the instrument from which the sound is emitted. 4th, That wind greatly affects sound in point of intensity; and that it affects it also in point of velocity. 5th, That when the direction of the wind concurs with that of the sound, the sum of their separate velocities gives the apparent velocity of sound; when the direction of the wind opposes that of the sound, the difference of the separate velocities must be taken. 6th, That in the case of echoes, the velocity of the reflected sound is the same as that of the direct sound. 7th, That, therefore, distances may frequently be measured by means of echoes. 8th, That an augmentation of temperature occasions an augmentation of the velocity of sound, and *vice versâ*.

**Sound**, the French academicians made, in 1738, some experiments for measuring the velocity of sound: the Board o. Longitude renewed these investigations in modern times, with all possible precision, when they found that the velocity of sound in the air, at the temperature of 55 degrees Fahrenheit, differs very little from 1044 feet per second.

**Soundboard**, in on Organ, is a reservoir into which the wind, drawn by the bellows, is conducted by a port vent, and hence distributed into the pipes placed over holes in its upper parts.

**Sound**, in Geography, denotes in general any strait, or inlet, of the sea, between the two headlands.

**SOUNDING**, the operation of trying the depth of the water, and the quality of the ground, by means of a plummet sunk from a ship to the bottom. For sounding there are two plummets used, one of which is called the hand-lead, weighing about eight or nine pounds; and the other, the deep sea-lead, weighing from twenty-five to thirty pounds, and both are shaped like the frustum of a cone or pyramid. The former is used in shallow waters, and the latter at a great distance from the shore, particularly on approaching the land after a sea voyage. Accordingly the lines employed for this purpose are called the deep sea-lead, and the hand lead-line. The hand lead-line, which is generally twenty fathoms in length, is marked at every two or three fathoms, so that the depth of water may be ascertained either in the day or night. At the depth of two or three fathoms there are marks of black leather; at five fathoms there is a white rag; at seven a red rag; at ten black leather; at thirteen black leather; at fifteen a white rag; and at seventeen a red rag. Sounding with the hand lead, which is called heaving the lead by seamen, is generally performed by a man who stands in the main-chains to windward. Having the line all ready to run out without interruption, he holds it nearly at the distance of a fathom from the plummet, and having swung the latter backwards and forwards three or four times, in order to acquire the greater velocity, he swings it round his head, and thence as far forward as is necessary; so that by the lead's sinking while the ship advances, the line may be almost perpendicular when it reaches the bottom. The person sounding then proclaims the depth of the water, in a kind of song, resembling the cries of London hawkers. Thus if the mark of five fathoms is close to the surface of the water, he calls, "By the mark five," and as there is no mark at four, six, eight, &c. he estimates those numbers, and calls "By the dip four." If he judges it to be a quarter or a half more than any particular number, he calls, "And a quarter five," "And a half four," &c. If he perceives the depth to be three quarters more than a particular number, he calls it a quarter less than the next; then at four fathoms and three quarters, he calls "A quarter less five," &c. The deep-sea lead is marked with two knots at twenty fathoms, three at forty, four at fifty, and so on to the end. It is also marked with a single knot in the middle of each interval, as at twenty-five, thirty-five, forty-five fathoms, &c. To use this lead more effectually at sea, or in deep water on the sea-coast, it is usual previously to bring-to the ship in order to retard her course; the lead is then thrown as far as possible from the ship on the line of her drift, so that as it sinks the ship drives more perpendicularly over it. The pilot feeling the lead strike the bottom, readily discovers the depth of the water by the mark on the line nearest its surface.

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* The consecution of the notes in a tune, notwithstanding the difference in their intensity, being uninterrupted when heard at a distance, furnishes an elegant and decisive confirmation of this proposition.

*In* SOUNDINGS, implies the being so near the land, as that a deep sea lead will attain the bottom, which is seldom practicable in the ocean.

SOUNDINGS, is also a name given to the specimen of the ground; a piece of tallow being stuck upon the base of the deep-sea lead, brings up distinguishing marks of the bottom, as sand, shells, ooze, &c. which adhere to it. The soundings, *i. e.* the depth of the water and the nature of the ground, are carefully marked in the log-book, as well to determine the distance of the place from the shore, as to correct the observations of former pilots.

SOUNDING *Rod*, a long piece of iron, marked with feet and inches, which being let down by a line in a groove by one of the pumps, indicates what water there is in the well, and consequently whether or not the ship leaks.

SOUP, a kind of pottage made of bread, broth, or the juice of flesh, with various other ingredients, usually served up at the beginning of a meal. *Portable Soup*, is a kind of cake, formed of concentrated broth, which being freed from all fat, and by long boiling having the most putrescent parts of the meat evaporated, is reduced to the consistence of glue, and will keep sound for many years. In long voyages this has been found to be a most valuable article of food.

SOUTH, one of the four cardinal points of the compass.

SOUTHING of the MOON, the time at which the moon passes the meridian of any particular place.

SOWING, in Agriculture, the act of scattering, or putting the seeds of grain, plants, &c. on or into the ground, in order to their producing crops.

SPACE, in Geometry, denotes the area of any figure, or that which fills the interval or distance between the lines that terminate it.

SPACE, in Mechanics, the line a moveable body, considered as a point, is conceived to describe by its motion.

SPADE, a well-known tool used in digging the soil; but its form is varied, according to the purposes to which it is applied.

SPADING, in Agriculture, is the taking off the sward or surface of grass land by means of the paring spade, with an intent to burn it.

SPAN, among Sailors, a small line or cord, the middle of which is usually attached to a stay, whence the two ends branch outwards to the right and left, having either a block or thimble attached to their extremities. It is used to confine some ropes which pass through the corresponding blocks or thimbles. To span in the rigging, is to draw the upper parts of the shrouds together by tackles, in order to seize on the catharping legs.

SPAN, a measure taken from the space between the thumb's end and the tip of the little finger, when both are stretched out. The span is estimated at three handbreadths, or nine inches.

SPANDRIL, in Architecture, the open space between the outward moulding of an arch, from its impost to the horizontal member or line which surrounds it.

SPANKER, another name for a ship's Driver, which see.

SPAR, in Mineralogy, a name given to those earths which break easily into rhomboidal, cubical, or laminated fragments with polished surfaces.

SPARE, an epithet applied to any part of a ship's equipage that lies in reserve, to supply the place of such as may be lost or rendered incapable of service; hence we say, spare tiller, spare top-masts, spare sails, &c.

SPARROW. *See* FRINGILLA.

SPARROW-HAWK. *See* FALCO.

SPARS, large round pieces of timber, fit for making top-masts, &c.

SPASM, in Medicine, a cramp: in its modern sense it signifies a continued and painful contraction of a muscle, or any portion of muscular fibres, and in this signification it stands opposed to convulsion.

SPATULA, an instrument used by surgeons and apothecaries for spreading plasters, &c.

SPAVIN, a disease in horses, which being a swelling or stiffness usually in the ham, causes them to halt.

SPAWN, in Gardening, the progeny of plants, or other vegetables, which consists of such small offsets, suckers, and sprouts, as rise numerously from the root of the parent stock. These being taken off and planted, will readily take root, and become proper plants.

SPAWN, *Mushroom*, generated in old hot-beds, stable dung moderately dry, and the yards of livery stables, is the seed whence new crops of mushrooms spring.

SPAWN *of Fish*, the glutinous deposites, whence new generations, that continue the species, arise. Each kind has its own peculiar instinct, in reference to the manner, time, and place, of providing for its young; but the variations and singularities of the tribes belong to the natural history of the species.

SPAYING, an operation performed on the females of several kinds of animals, to prevent any further conception, and promote their fattening.

SPEAKER, of the House of Commons, a member of the house elected by a majority of the votes thereof, to act as chairman or president in putting questions, reading briefs or bills, keeping order, reprimanding the refractory, adjourning the house, &c. The first thing done by the commons, upon the first meeting of a parliament, is to choose a speaker, who is to be approved of by the king, and who, upon his admission, begs his majesty that the commons during their sitting may have free access to his majesty, freedom of speech in their own house, and security from arrests. The speaker is not allowed to persuade or dissuade in passing a bill, but only to make a short and plain narrative; nor to vote, unless the house be equally divided.

SPEAKING TRUMPET, a tube formed to collect the impulses of sound in speaking, and convey them forward to a distance. *See* ACOUSTICS.

SPEAR. *See* LANCE.

SPEARWORT, in Botany, the *Ranunculus Flamineus*, generally deemed poisonous, but frequently used for medical purposes. The leaves, bruised to a kind of paste, and applied to the skin, will soon raise a blister. To sheep it proves very pernicious.

SPECIES, a term of relation. It comprises any number of individuals of the same common character, and yet it is less comprehensive than the term genus. That, however, which is a species in one relation, may become a genus in another. Thus, animal is a species as ranged under Body, but it is a genus in reference to Man, who now becomes a species of the more generic term Animal.

SPECIES, in Algebra, the characters or symbols made use of to represent quantities.

SPECIFIC, in Medicine, a remedy whose virtue and effect is peculiarly adapted to some certain disease, is adequate thereto, and exerts its whole force immediately thereon.

SPECIFIC GRAVITY, the relative weight of equal portions of different kinds of matter. For fluids and solids, the common standard of reference is pure distilled water at 62° Fahrenheit, which a cubic foot will weigh 1000 ounces. The specific gravity of water is called 1, or 1000.

SPECIFICATION, a statement of particulars given by a builder, an engineer, or artist, describing the dimensions and the peculiarities of the work he is about to undertake. Specifications must always be given when patents are to be obtained.

SPECTACLE, some remarkable object which arrests, or is designed to arrest, public attention. It is presumed to be always beheld with some passion or emotion of the mind.

SPECTACLES, an optical instrument, consisting of two lenses set in a frame, and fixed at a convenient distance before the eyes, to assist the sight. Spectacles are said to have been invented about the year 1299; but several individuals claim the honour of this discovery.

SPECTRUM, in Optics. When a ray of light is admitted through a small hole, and received on a white surface, it forms a luminous spot. If a dense transparent body be interposed, the light will be refracted in proportion to the density of the medium; bu if a triangular glass prism be interposed, the light is not merely refracted, but it is divided into seven different rays. The ray of light no longer forms a luminous spot, but has assumed an oblong shape, terminating in semicircular arches, and exhibiting seven different colours. This image is called the spectrum, and, from being produced by the prism, the prismatic spectrum. These different coloured rays appearing in different places of the spectrum, shew that their refractive power is different. Those which are nearest the middle are the least refracted, and those which are the most distant, the greatest. The order of the seven rays of the spectrum is the following: red, orange, yellow, green, blue, indigo, violet. The red, which is at one end of the spectrum, is the least, and the violet, which is at the other end, is the most refracted. Sir Isaac Newton found, if the whole spectrum was divided into 360 parts, the number of the parts occupied by each of the colours to be the following:—red, 45 parts; orange, 27; yellow, 48; green, 60; blue, 60; indigo, 40; and violet, 80. These different coloured rays are not subject to further division. No change is effected upon any of them by being further refracted or reflected; and as they differ in refrangibility, so also do they differ in the power of inflection and reflection. The violet rays are found to be the most reflexible and inflexible, and the red the least.

**SPECULARES**, the name of a genus of fossils of the talc class.

**SPECULUM**, in Catoptrics, is a metallic reflector made use of in catadioptric telescopes, instead of the object-glass used in dioptric telescopes.

**SPEECH**, the act or art of expressing thought by articulate sounds, or signs invented for that purpose.

**SPEEDWELL.** *See* Veronica.

**SPELL**, a kind of charm to drive away disease by hanging a piece of paper round the neck. It also signifies the extending an indefinite but strange influence over a person, which prevents the regular use of his natural powers. Spell is likewise used for a given period, during which one man or party relieves another in doing something that is laborious. In this sense it is common among sailors and miners.

**SPERMACETI.** This peculiar oily substance is found in the cranium of the physeter monocephalus, or spermaceti whale. It is obtained also from some other species.

**SPHERE**, in Mineralogy, a mineral composed of nearly equal parts of oxide of titanium, silex, and lime.

Sphere, is a solid contained under one uniform round surface, such as would be formed by the revolution of a circle about a diameter thereof as an axis.

Sphere, in Astronomy, that concave orb, or expanse, which invests our globe, and in which the heavenly bodies appear to be fixed and at equal distance from the eye.

**SPHERICS**, the doctrine of the sphere, particularly of the several circles described on its surface, with the method of projecting the same on a plane.

**SPHEROID**, a solid body approaching to the figure of a sphere, though not exactly round, but having one of its diameters longer than the other.

**SPHINX**, the *Hawk moth*, a genus of insects of the order lepidoptera. The generic character is, antennæ thickest in the middle, subprismatic, and attenuated at each extremity; wings deflected; flight strong, and commonly in the morning or evening.

**SPHINX**, in Sculpture, a figure representing a fabulous monster of that name. It is portrayed with the head and breasts of a woman, the wings of a bird, the claws of a lion, and the other parts of the body like those of a dog or lion.

**SPHRAGIDE**, or *Lemnian Earth*, in Mineralogy, a substance resembling fuller's earth, found in the island of Lemnos in the Mediterranean. It is in high repute in the East as an antidote against poison and the plague, and is dug only once a year, and that with great solemnity.

**SPICA VIRGINIS**, a star of the first magnitude in the constellation Virgo.

**SPICE**, any kind of aromatic drug that has hot and pungent qualities; such as pepper, nutmeg, ginger, cinnamon, and cloves. Some include under this term senna, cassia, frankincense, &c.

**SPIDER**, a creature too well known to require any particular description. Of this genus one hundred and twenty species have been enumerated; and of some, the natural history is exceedingly curious.

**SPIELMANNIA**, a genus of the didynamia angiospermia class and order.

**SPIGELIA**, Wormgrass, a genus of plants belonging to the class of pentandria, and order of monogynia; and in the natural system arranged under the 47th order, stellatæ.

**SPIKE**, in Gunnery, to choke up the touch-hole with a nail, or something made on purpose, so as to render that piece of ordnance useless. Spike is also the nail or instrument with which the act is effected.

**SPIKING** *up the Ordnance*, a sea phrase used for fastening a quoin with spikes to the deck close to the breech of the carriage of great guns, that they may keep close and firm to the ship's sides, and not get loose when the ship rolls, and by that means endanger the breaking out of a butt-head of a plank.

**SPINACIA**, Spinach, a genus of plants belonging to the class of diœcia, and to the order of pentandria; and in the natural system arranged under the 12th order, holoraceæ.

**SPINDLE**, on Ship Board, a sort of iron pin tapering at the upper end to a point. It is fixed into the upper end of the top-gallant mast, so as to carry a vane, which turning thereon horizontally, shews the direction of the wind.

Spindle, is also the name of the lower end or foot of a capstan, which is shod with iron, and becomes the pivot or axis on which it turns in the saucer.

**SPINE**, the backbone in any animal, but, in reference to man, it is the articulated bony pillar at the back of the trunk, forming the foundation or basis of support and connexion to all the other parts of the frame.

**SPINELL.** *See* Ruby.

**SPINET**, or Spinnet, a musical instrument ranked in the second or third place among harmonious instruments.

**SPINNING**, the art of combining animal or vegetable fibres into threads or cords, by twisting them together. Wool, silk, cotton, flax, and hemp, are the matters most commonly employed for spinning into threads; and of these most of the vegetable fibres, except cotton, require to be wetted during the operation of spinning, to render them more supple; but cotton, wool, and silk, are spun in a dry state. The machines employed for spinning are of very different kinds, and adapted to the materials to be operated upon; but they have all a spindle, revolving with a rapid motion to twist the fibres which are attached to the end of it, and are supplied in a regular quantity, as fast as the twisting motion of the spindle will form them into a thread; and there is also some provision of a bobbin upon the spindle, to take up and retain the thread when made.

The most ancient mode of spinning is by the spindle and distaff, which, though exceedingly simple, was attended with much labour, and as the produce was small, the original method was laid aside. This simple but inconvenient method of spinning, however, becomes very efficient, when the spindle, instead of being spun upon the ground, is mounted in a proper frame and turned by a wheel and band: this forms a machine which is called the one-thread wheel, and is still used in the country for spinning wool; the spindle is made of iron, and placed horizontally, so that it can revolve freely; and the extremity of the spindle, to which the thread is applied, projects beyond the support. The wheel which turns it is placed at one side, the pivots of both being supported in upright pieces, rising up from a sort of stool. The spinner puts the wheel in rapid motion by its handle, and its weight is sufficient to continue the motion for some seconds; then walking backwards from the spindle, in the direction of its length, she supplies the fibres regularly, and the motion twists them into a thread; but when a convenient length is spun, the spinner steps on one side, and reaches out that arm which holds the end of the thread, so as to alter the direction of the thread, and bring it nearly perpendicular to the length of the spindle, which motion gathers or winds up the thread upon the middle of the projecting part of the spindle. This being done, she holds the thread in the direction of the spindle, so that it will receive twist, and retreats again to spin a fresh length of thread. For spinning wool, it is not wound round the distaff the same as flax, but the spinner holds a lock of it doubled over the fore-finger, and draws away the fibres from the middle part of a lock, to do which with regularity is the great art of spinning by hand.

A spinning machine more perfect than this is the one-thread flax-wheel, with spindle and flyer; it has the property of constantly drawing up the thread as fast as it is spun, instead of spinning a length and then winding it upon the spindle.

An improvement was made in the spinning wheel by Mr. Antis some years ago, which was an application of what Sir Richard Arkwright had before invented. The object is to obviate the necessity of stopping the wheel to remove the thread from one hook to another, in the manner just described. For this purpose the bobbin is made to move regularly backwards and forwards upon the spindle, a space equal to its length, so that every part will in succession be presented opposite the hook over which the thread passes, and thus receive the thread regularly upon the whole length of the bobbin. The invention has also another advantage over the old method, which always winds the thread in ridges upon the bobbin, and if the thread breaks in reeling the yarn, the whole bobbin may as well be thrown away, because the thread cannot easily be found again but this improved wheel always winds the threads across upon one another, by which means the end can never be lost.

It was not until the latter end of the last century, that spinning machines of greater powers were constructed; but all threads were spun by one of the machines which we have described; the first being used for cotton and wool, and the other with the bobbin and flyer, for flax; but for the very coarse threads, two spindles were applied to the latter machine, and the spinner having the wool wound round a band, tied it round her waist instead of winding it upon a distaff, and was thus able to draw out fibres with each hand, and supply two spindles. The first improvement of any importance in spinning, was that of the spinning jenny invented by Mr. Hargraves, as related in our article WEAVING. This was followed by the slubbing machine or billy, which by preparing the rovings for the jenny, a work which was previously performed by the hand, was deemed a considerable acquisition.

The inventions of Sir Richard Arkwright soon superseded these machines. His principal invention in the spinning was the introduction of the rollers to draw out or extend the fibres to their full length, which is by this means much more perfectly performed than by the fingers of the spinner. For the immediate twisting of the thread, he adopted the spindle, bobbin, and flyer of the old flax-wheel, placed in a vertical position, but added to it the important improvement of raising and lowering the bobbin, to distribute the thread regularly and equally upon all the length of it, the same which we have before described as being applied by Mr. Antis to the common spinning-wheel. The spinning jenny was again introduced, and rendered equal, and for some purposes superior, to the water frame, by Mr. Crumpton, who combined with it the system of rollers, of Sir Richard Arkwright, and called the mule.

The great success attending the spinning of cotton by these machines, induced many persons to attempt the spinning of flax and wool by similar means. Short wool, for the manufacture of cloth, is spun by the billy and jenny; but flax and long wool for worsted require very different treatment from cotton and short wool, particularly the flax, owing to the great length of the fibres, and to their being of such irregular lengths; in consequence, when they are extended by the rollers on Arkwright's principle, some fibres will be broken, if the distances between the rollers is too small: and on the other hand, if the distance is too great, the fibres will not be properly extended. The latter, however, is the least evil of the two; and in consequence, the spinning frames for flax have the rollers, between which the extension or drawing out is effected, placed at a distance of from 14 to 18 inches between the first two pair of rollers, through which the flax passes; the next two pair, six or eight inches; after which it is passed between the third pair of rollers at a distance of five or six inches, and then delivered to the spindles, which are similar to those of the water-frame, but placed in an inclined position. The rollers are made in a very different way from those for cotton, being only narrow wheels just wide enough to receive the fibres of flax between them; and the fibres are prevented from getting out sideways by small tin spouts, through which the flax passes, as the rollers draw it forwards. The reason of this is, that the flinty surface of the flax would soon wear a hollow part round a plain roller, which would then let the flax slip through; but the narrow wheel wears down equally over the whole breadth of its edge. The lower pair of these rollers, or wheels, revolves in a small trough of water, in the same manner as a grindstone, and thus keeps the flax constantly wet, which is necessary, in order to soften the fibres, and make them spin into a firm and smooth thread.

Worsted is also spun in a frame resembling the water-frame of Arkwright, from which it only differs in the relative distances of the rollers, by which the drawing out or extending of the fibres is effected.

Messrs. Clarke and Bugby obtained a patent in 1806, for improvements in a machine for spinning hemp and flax, which is intended to be worked by hand labour, and to be at such a small expense, as to bring it within the reach of small manufacturers. The inventors state it to be constructed upon such safe and easy principles, that no length of experience is necessary to enable children to work it; and that it occupies so little space, that the machines may be placed in small rooms, outbuildings, and other cheap places. To effect the above purposes, it was necessary to get rid of the flyer fixed upon the spindle used in the old machinery for spinning hemp or flax, which additions require a power in proportion of five to one; and also to surmount the difficulty which arises from the want of elasticity in these substances, and which prevents them from being spun by stretching out, at the same time that the thread is twisted in the manner of the mule or jenny. For further particulars see COTTON.

SPINNING *Wheel*, in Rope-making, for twelve spinners to spin yarn at the same time is about five feet in diameter, and is hung between two posts fixed in the ground: on its top is fixed a semicircular frame, called the head, which contains 12 whirls, that turn on iron spindles, with hooks to their front ends to hang the hemp on, and are worked by means of a leather band encircling the wheel and whirls. The whirls are made to run with a truer motion when the head on the rising side of the band has a larger segment of a circle than the falling side; or, in other words, let the base part of the head be longer from the middle than the opposite or falling side, by which means the band will be kept equally tight over the whirls, and consequently the motion will be alike to all. Heads made in this manner have the wheels turned always the same way.

SPINSTER, in Law, an addition usually given to all unmarried women, from a viscount's daughter downward.

SPIRACULA, in Entomology, holes or pores on each side of every segment of the abdomen, through which insects breathe.

SPIRAL, in Architecture and Sculpture, implies a curve that ascends winding about a cone or spire, so that all the points thereof continually approach the axis.

SPIRAL, in Geometry, a curve line of the circular kind, which in its progress recedes from its centre.

SPIRALE, PROPORTIONAL, are such spiral lines as the rhumb lines on the terrestrial globe.

SPIRIT, in Physiology, the most subtle and volatile part or juice of the body, by means of which its various functions and operations have been supposed to be performed. For Spirits distilled, see ARAC, BRANDY, RUM, &c.

SPIRIT, in Theology, signifies any incorporeal being that possesses intelligence. In the highest sense, God is a spirit; angels, devils, and the souls of men, are spirits. The term is more emphatically applied to the Holy Ghost. On the nature, qualities, and peculiar properties of spirit, the disputations among divines and metaphysicians have been carried to an almost immeasurable length.

SPIRITUALIZATION, in Chemistry, the act of extracting spirits from natural bodies.

SPIRKETING, that range of planks which lies between the water-way and the lower edge of the gun-ports withinside of a ship.

SPLICING, among Seamen, to join the two ends of a rope together, or to unite the end of a rope to any part thereof, by interweaving the strands in a regular manner. There are several methods of splicing, according to the services for which it is intended; all of which are distinguished by particular epithets.

The short splice, is used upon the cables, slings, block-strops and in general all ropes which are not intended to run through blocks, or where the splice is not in danger of being loosened. It is made by untwisting the ends of two ropes, or the ends of one rope, and having placed each of the strands of one opposite, and in the interval between two strands of the other, by penetrating the latter with a fid or marline spike, parallel to the axis or length of the rope.

The long splice, occupies a greater extent of rope, but by the three joinings being fixed at a distance from each other, the increase of bulk is divided; hence it is much neater and smother than the short splice, and better adapted to run through the channel of a block, &c. for which use it is generally intended.

The eye-splice, forms a sort of eye or circle at the end of a rope, and is used for splicing in thimbles, bulls-eyes, &c. and sometimes on the end of block-strops. The strands are therefore untwisted, and their extremities thrust through the three strands in that part of the rope whereon the splice is to be formed, and thence passing over the surface of the second strand, they are again thrust through the third, which completes the operation. There are other names for splices made in a similar manner to the eye-splice, but for a different purpose, being chiefly used in lead-lines, log-lines, and fishing lines, where the short splice would be liable to separation, as being frequently loosened by the water. It is made by splicing the ends of two lines at a short distance from each other; and the extremities of each being interwoven into the bight of the other lines, becomes double in the extent of the splice.

SPLINTERS, the pieces of a ship's side, masts, decks, &c. which being knocked off by a shot, acquire great velocity, and frequently do more damage among the men than the shot itself.

SPLINTER-*Netting*, sinnet made into nets, and nailed upon the inner part of the ship's sides, to lessen the effect of the splinters.

SPOILS, whatever is taken from an enemy in war; it is frequently denominated booty.

SPONDEE, SPONDÆUS, in ancient Poetry, a foot consisting of two long syllables as, *om-nes.*

SPONGIA, SPONGE, in Natural History, a genus of animals belonging to the class of vermes and order of zoophyta. It is fixed, flexible, and very torpid, growing in a variety of forms, composed of reticulated fibres, or masses of small spines interwoven together, and clothed with a living gelatinous flesh, full of small mouths or holes on its surface, by which it sucks in and throws out the water.

SPONGIOSE, in Anatomy, an appellation given to several parts of the body.

SPONSORS. *See* GODFATHERS.

SPONTANEOUS COMBUSTION. Many vegetable substances, highly dried, and heaped together, will heat, scorch, and at last burst into a flame. Of those, the most remarkable is a mixture of the expressed oil of the farinaceous seeds, as rape or linseed oil, with almost any dry vegetable fibre, such as hemp, cotton, matting, &c. and still more so, if also united with lamp-black or any other carbonaceous substance. These mixtures, if kept for a time undisturbed in close bundles, and in a warm temperature, even in small quantities, will often heat and burn with a smothered fire for some hours; and if air be admitted freely, will then burst into flame. To this, without doubt, may be attributed several accidental conflagrations in storehouses, and places where quantities of these substances are kept.

SPONTOON, is a weapon much like a halberd, formerly used instead of a half-pike, by the officers of foot.

SPOONDRIFT, a sort of showery sprinkling of the sea-water, swept from the surface of the waves in a tempest, and flying according to the direction of the wind.

SPOTS, in Astronomy, dark places observed on the discs of the sun, moon, or planets. These were first discovered by Galileo in the year 1610, soon after he had completed his telescope.

SPOUT, the name of a trunk for conveying water from off the tops of buildings.

SPOUT, *Water*, or *Water Spout*, in Natural History, is an extraordinary elevation of the water at sea, and is very dangerous to ships. Its first appearance is in the form of a deep cloud, the upper part of which is white, and the under black. From the lower part of this cloud hangs down a conical tube, its biggest end at the top, which is called the spout. Under this tube the sea appears in a state of boiling agitation; the water rises, and stands as a column or pillar, some yards above the common surface; and from its extremity it spreads around in a kind of smoke. Many instances have occurred where the water has risen when no spout has been visible. Water spouts generally appear in warm dry weather, and when the sea is calm. This phenomenon is supposed, by some, to be occasioned by electricity, while others ascribe it to the meeting of contrary winds. It is, however, admitted, that water-spouts frequently appear without any indications of an adequate cause.

SPRAT, a small fish well known in London and other markets. The usual length is about four or five inches, and the body deep. From its superficial appearance some have erroneously thought it to be a young herring. But a minute examination will prove the species to be distinct.

SPRAY, the sprinkling or foam of the sea, which is driven from the top of a wave in stormy weather. It differs from the spoondrift, as being only blown occasionally from the broken surface of a high wave; whereas the latter continues to fly horizontally along the sea without intermission during the excess of a tempest or hurricane. It is sometimes called spry.

SPRING, in Natural History, a fountain or source of water rising out of the ground.

SPRING, in Mechanics, denotes a thin piece of tempered steel, or other elastic substance; which being wound up, serves to put several machines in motion by its elasticity, or endeavour to unbend itself; such is the spring of a clock, watch, &c.

SPRING, among Sailors, implies a crack running transversely or obliquely through any part of the mast or yard, so as to render it unsafe to carry the usual quantity of sail thereon

SPRING, is also a rope passed out of a ship's stern, and attached to a cable proceeding from her bow, when she lies at anchor. It is usually performed to bring the ship's broad side, or battery of cannon, to bear upon some distant object, as another ship, a fortress on the coast, &c. When a ship rides by anchors which are only attached to one end, she will move like a weather-cock, according to the direction of the wind or tide. Now, if a rope be extended to the other end to the same anchor, it is evident that by slackening one of these ropes, and keeping the other fast, her side will lie more or less obliquely to the wind or tide as occasion may require, so as to be opposed to any distant object to the right or left. For instance, if a ship ride with her head northerly, and is required to cannonade a fortress lying on the south or south-east, a hawser is run out of the stern, and being carried forward without her fid, is attached to the cable, at a competent distance ahead of the ship; the hawser is then tightened by the capstan or tackles, and the cable being slackened the ship immediately turns her side towards the object intended to be battered.

SPRING, is likewise a rope extending diagonally from the stern of one ship to the head of another which lies abreast of her at a short distance, and is performed to make one of the ships sheer off to a greater distance from the other. Springs of this kind are occasionally applied to a wharf or pier for the same purposes.

*To Spring a Mast, Yard*, &c. is to crack it transversely or obliquely.

SPRING *Tide*, the periodical excess of the elevation and depression of the tide, which happens soon after the new and full moon.

SPRINGS. *On the different Properties of Metal and Wooden.*— The spring is not only a very useful auxiliary, but an indispensable requisite, in many pieces of mechanism. But, from the difficulty of getting springs to stand, as the workmen express it, to their temper, they are not so frequently applied to the purposes of mechanics as otherwise they might be. Great judgment and skill, as every one knows who is conversant with the subject, are required, to give to a metal spring its due degree of temper; for, if made too hard, it snaps; if not hard enough, it sets. Metal springs, however, frequently fail from another cause, which is very little understood; in consequence of which, the failure is usually attributed, though, as presently will be seen, unjustly, to the unskilfulness of the workman. It is a circumstance not commonly observed respecting a metal spring, that if it has not something to stop against, but is suffered to vibrate after performing the requisite action, it will, in a short space of time, if the action be frequently repeated, either break or set. Whence this property arises, is not at present the object of inquiry. It is mentioned, that, in cases which will admit of it, this inconveniency may be guarded against. In those cases in which the vibration cannot conveniently be avoided, a wooden spring, which is not subject to the like inconvenience, is the best, and perhaps the only substitute. A wooden spring is, in the property alluded to, the reverse of a metal one: if stopped in its vibration, it soon sets or breaks; if permitted to vibrate, its temper or elasticity suffers not the smallest diminution. Some years ago, the Reverend Edmund Cartwright established a mill for a manufacturing purpose, (we believe, for weaving by power, which was first introduced by him, and for which he was afterwards rewarded by parliament.) In this mill he had occasion to apply springs, under the circumstances mentioned above; he at first attempted to make use of metal ones, but in vain, being never able to make them stand a single day's work. He tried every kind of steel, and employed many different workmen, but still without success. Merely as a temporary expedient, till such time as he could get a fresh supply of steel springs, he one day tried a wooden one, which, to his agreeable surprise, completely answered his purpose; and from that time, as may be concluded, he never used any other than wooden ones. The experiment was perfectly decisive: the springs were in daily action for four years successively, making, in a common way, from forty to fifty strokes in a minute, on an average. At the expiration of the four years, those springs which had escaped accidents were as elastic, and as strong, as when first put into action. The wood they were made of was red deal, clean grained, and perfectly free from knots. To many manufacturers who employ machinery for various purposes, in which springs, that must be suffered to vibrate, form a part, this information, which may to some appear trivial, will be found highly useful.

SPRINGES, a sort of noose made of horse-hair, and sometimes spread on the ground, supported by a twisted willow, to ensnare birds. Springes are, however, used in various other ways, being occasionally set in hedges, on the boughs of trees, and in other places to which birds resort.

SPRIT, a small boom or pole, which crosses the sail of a boat diagonally from the mast to the upper aftmost corner, which it is used to extend and elevate; the lower end of the sprit rests in a sort of wreath, called the snotter, which encircles the mast at that place. These kind of sails are accordingly called sprit-sails.

Sprit *Sail*, is also a sail attached to a yard which hangs under the bowsprit. It is furnished with a large hole towards each of its four corners, to evacuate the water with which the cavity or belly of it is frequently filled by the surge of the sea, when the ship pitches.

Sprit *Sail Top-sail*, a sail extended above the former by a yard which hangs under the jib-boom; the clues of this sail are hauled home to the sprit-sail yard arms, after which the sail is drawn out towards the extremity of the boom, as any other top-sail yard is hoisted upon its mast. Formerly, the sprit-sail top-sails were set on a mast which was erected perpendicularly on the end of the bowsprit, but this method has of late been justly rejected as inconvenient and dangerous to the bowsprit, although serviceable in light breezes.

Sprit *Sail Top-gallant Sail*, is set upon the flying jib-boom, in the same manner that the sprit-sail top-sail is set upon the inner jib-boom: this sail is, however, very rarely used.

SPROUT, the common name of a young shoot, offset, or sucker, which is thrown out by the parent plant or tree.

SPRUCE-BEER, a cheap and wholesome liquor, which is thus made: Take of water sixteen gallons, and boil the half of it. Put the water thus boiled, while in full heat, to the cold part, which should be previously put into a barrel, or other vessel; then add sixteen pounds of treacle or molasses, with a few table-spoonfuls of the essence of spruce, stirring the whole well together; add half a pint of yeast, and keep it in a temperate situation, with the bung-hole open for two days, till the fermentation is abated. Then close it up, or bottle it off, and it will be fit for being drunk in a few days afterwards.

SPUNGE, an instrument used to clean the cannon after firing, and to extinguish any sparks that may remain behind. They are sometimes made of bristles resembling a round brush, but more generally of sheep-skin with the wool outwards, nailed upon a block of wood nearly as large as the caliber of the piece The block is either fixed upon a long wooden staff, or upon a thick piece of rope, well stiffened by serving it with spun-yarn. This latter is much more convenient on board of ships, on account of its flexibility; and is generally furnished with a block at the upper end, to use as a rammer. To spunge a gun, is to clean it out with the sponge; and should be constantly repeated after every explosion.

Spunge, or Sponge, a marine substance found adhering to rocks, shells, &c. under cover of the sea-water, or on the sides of rocks regularly visited by the tides. It was long disputed whether this production of nature belonged to the mineral, the vegetable, or the animal kingdom; but it is now ascertained to be of animal origin, being the fabric and habitation of some species of worm or polype.

SPUN-YARN, a small line or cord formed of two, three, or more rope-yarns, twisted together by a winch; the yarns are usually drawn out of the strands of old cables and knotted together. Spun-yarn is used for various purposes, as seizing and serving-ropes, weaving mats, &c.

SPUR, a piece of metal, consisting of two branches encompassing a horseman's heel, and a rowel, in form of a star, advancing out behind to prick the horse.

SPY, a person hired to watch the actions, motions, &c. of another, particularly of what passes in a camp. When a spy is discovered he is hanged immediately.

SQUACCO, a large bird of the heron kind, that is bold and fierce. Its head is adorned with a crest of black, white, and yellow; and its plumage is variegated throughout with the same tints.

SQUAD, in Military language, denotes a small number of horse or foot, collected for the purpose of exercise.

Squad, *Awkward*, consists of such recruits, and others, as cannot go regularly through their military evolutions. It is frequently used as a term of reproach to such officers and men as are deficient in their duty.

SQUADRON, in Military Affairs, denotes a body of horse, whose number of men is not fixed, but is usually from one to two hundred. Each squadron usually consists of three troops of fifty men each.—Squadron, in Naval Affairs, either implies a detachment of ships employed on any particular expedition, or one-third part of a naval armament.

SQUALL, a sudden and violent gust of wind, usually occasioned by the interruption and reverberation of the wind from high mountains. These are very frequent in the Mediterranean, particularly that part of it which is known by the name of the Levant, as produced by the repulsion and new direction which the wind meets with in its passage between the various islands of the Archipelago.

*A Black* Squall, one attended with a dark cloud, which occasions a diminution of the usual quantity of light. *A White Squall*, produces no such diminution. *A Thick Squall*, is accompanied with rain, sleet, &c.

SQUALUS, the *Shark*, in Natural History, a genus of fishes of the order cartilaginei. These animals are never found in rivers or lakes, inhabiting only the sea, and carrying terror and destruction wherever they appear. They grow in some species to the weight of three or four thousand pounds. They occasionally emit a phosphoric illumination, visible by night. They produce their young alive, several at a birth, but every one enclosed in a transparent hornlike substance, lengthened at the extremity into a thread which attaches to fixed substances, such as rocks or weeds. Some appear to live on vegetables chiefly, but the greater number are rapacious of animal substances in the extreme. They seize, indeed, whatever they find, with the most violent avidity, following in the wakes of ships, for the sake of nearly every thing thrown from them, and are fatal to those mariners who slip from their hold on the rigging into the sea, in which case the sharks are seen to tear them to pieces, with all the violence of competition. They are in most instances solitary wanderers through the ocean, but in some species they are gregarious. They contain large quantities of oil, and their skin is convertible to several useful purposes.

SQUARE, among Sailors, is a term peculiarly appropriated to the yards and their sails, either implying that they are at right angles with the mast or keel, or that they are of greater extent than usual. Thus, when the yards hang at right angles with the mast, they are said to be square by the lifts; when they hang perpendicular to the ship's length, they are called square by the braces; but when they lie in a direction perpendicular to the plane of the keel, they are square by the lifts and braces; or, in other words, they hang directly across the ship, and parallel to the horizon. The yards are said to be very square, when they are of extraordinary length, and the same epithet is applied to their sails with respect to their breadth.

Square-*rigged*, is a vessel used in contradistinction to all vessels whose sails are extended by stays, lateen, or lug-sail yards, or by gaffs and booms, the usual situation of which is nearly in a plane with the keel.

Square *Sail*, is any sail extended to a yard suspended by the middle, and hanging parallel to the horizon, as distinguished from other sails which are extended obliquely. *Square Sail*, is also the name of a sloop's or cutter's sail, which hauls out to the lower yard, called the square-sail yard. This sail is only used in fair winds, or to scud in a tempest. In the former case it is furnished with a large additional part called the bonnet, which is then attached to its bottom, and removed when it is necessary to scud.

SQUARE. *See* Geometry.

Square Number, the product of a number multiplied into itself.

Square, in the Military Art, a particular formation into which troops are thrown on critical occasions particularly to resist the charge of cavalry.

SQUARE Solid, is a body of foot, where both ranks and files are equal. It was formerly held in great esteem; but when the prince of Nassau introduced the hollow square, this was soon neglected.

Square, *Hollow*, is a body of foot drawn up, with an empty space in the centre, for the colours, drums, and baggage facing every way, to resist the charge of the horse.

Square, *Oblong*, a square which is not at right angles, but represents the figure of an oblong, whose sides are unequal.

Square, *Perfect*, a square whose sides are equal and at right angles.

SQUILL, or Sea Onion, in the Materia Medica. The roots, or rather the bulbs, of this species, are the parts that are used in medicine. There are two sorts, the white and the red, but the latter is generally preferred. Squills grow naturally on sea-shores, or in ditches to which salt water has access. From Spain and the Levant, large quantities are annually imported into England.

SQUINTING, an irregular position and motion of the eyes, in which their axes do not converge to the object looked at.

SQUIRREL, a small animal well known in England, and in most other warm or temperate climates, where woods abound. During the summer it provides for the contingencies of winter, by laying up a store of nuts and other fruits. Its tail is formed chiefly of bushy hair, and being nearly as large as its body, serves it in some measure instead of wings, when darting from one tree to another, or even descending to the ground. Of the English squirrel the flesh is said to be delicate, and of an excellent flavour.

STABLE, a building constructed for horses and other animals, being furnished with stalls, and proper contrivances to contain their food and necessary equipments.

STACK, a quantity of corn, hay, pease, pulse, straw, or stubble, regularly piled up and thatched, to protect it from the inclemencies of the weather. Various forms prevail in different districts, and the dimensions are regulated by local circumstances.

STADIUM, an ancient Greek long measure, about a furlong.

STAFF, among Seamen, a light pole erected in different parts of a ship, whereon to hoist and display the colours. The *Ensign Staff*, is reared immediately over the stern, to display the ensign. The *Jack Staff* is fixed at the end of the bowsprit, to extend the jack. A *Flag Staff*, is erected at each of the mast-ends, or formed by their upper ends to support the flag or pendant of the respective squadron or division to which the ship belongs.

STAG, the *Red Deer*, or *Hart*.

STAGE, among Ship-carpenters, is a machine composed of planks, let over the sides by ropes, whereon the people may stand when repairing, caulking, or paying the ship's sides, wales, &c. A *Floating Stage*, is one which needs not the support of ropes, being sufficiently large and firm to bear upon the water.

STAGGERS, a disease in horses, nearly allied to apoplexy in human beings. It consists of a giddiness in the head, and is sometimes indicated by madness.

STAIRCASE, an ascent enclosed between two walls, or a balustrade, consisting of steps or stairs, with landing places and rails; serving to make a communication between the several stories of a house.

STALACTITE, or Stalactagmia, stony concretions resembling icicles, in Natural History; or crystalline spars formed into oblong, conical, round, or irregular bodies, composed of various crusts, and usually found hanging in form of icicles from the roofs of grottoes.

STALK, that part of a plant which rises immediately from the root, and supports the leaves, flowers, and fruits.

STAMINA, in the animal body, are defined to be those simple original parts, which existed first in the embryo.

STAMMERING, a hesitation in pronunciation, or interruption of speech, which seems generally to arise from fear, eagerness, or some violent passion. This should be checked as much as possible in its early stages, by slow and deliberate pronunciation; for once confirmed into a habit, it becomes inveterate.

STAMP Duties, a tax imposed upon all parchment and paper on which any legal proceedings are written; and also upon licenses for retailing wines; upon all almanacks, newspapers, advertisements, cards, dice, and pamphlets of a certain description.

Stamps, in Metallurgy, large heads of iron fastened to timbers that are lifted by the revolution of a water wheel. These falling on the ore that is incorporated with refuse, beat the whole to powder, that the valuable parts may be separated from the useless, and preserved.

STANCHIONS, those pillars which being set up pillar-wise, support and strengthen the waste-trees, but are chiefly intended to support the weight of the artillery. They are used for various purposes.

Stanchions of the *Nettings*, are either slender bars of iron whose lower ends are fixed in iron sockets at proper distances, or square wooden pillars let into the upper part of the ship's side.

STANDARD, in Ship-building, is an inverted knee, placed upon the deck instead of beneath it, and having its vertical branch pointed upwards from that which lies horizontally.

*Royal* Standard, a flag in which the imperial ensigns of England, Scotland, and Ireland, are quartered, together with the armorial bearings of Hanover. It is never hoisted unless when the king is on board, at which time it is displayed at the main-top-gallant-mast head.

Standard, in Commerce, the original of a weight, measure, or coin, committed to the keeping of a magistrate, or deposited in some public place, to regulate, adjust, and try the weights used by particular persons in traffic.

Standard, in Military affairs, a measure by which men enlisted into his majesty's service have the regulated height ascertained.

Standard, in War, a sort of banner or flag, borne as a signal for the joining together of several troops belonging to the same body.

STANDING, in the Sea Language. Standing part of the sheet, is that part of it which is made fast to a ring at the ship's quarter. Standing part of a tackle, is the end of the rope where the block is fastened. Standing ropes, are those which do not run in any block, but are set tawt or let slack as occasion serves, as the sheet-stays, back-stays, or the like.

STANNARIES, certain laws to which those who dig and purify tin in the counties of Cornwall and Devonshire are subject. There are four stannary courts for each of the above counties, to which appeals are made by the tinners, and in which justice is administered by the lord and vice-wardens, who preside. An appeal lies from these courts to the privy council of the prince of Wales, as duke of Cornwall, and thence, finally, to the king himself.

STANZA, in Poetry, a certain stated number of grave verses, containing a perfect sense, and terminated with some significant pause.

STAPLE, primarily signifies a public place or market, whither merchants, &c. are obliged to bring their goods to be bought by the people, as the Greve, or the places along the Seine, for sale of wines and corn at Paris, whither the merchants of other parts are obliged to bring those commodities. Formerly the merchants of England were obliged to carry their wool, cloth, lead, and other like staple commodities of this realm, in order to utter the same by wholesale; and these staples were appointed to be constantly kept at York, Lincoln, Newcastle upon Tyne, Norwich, Westminster, Canterbury, Chichester, Winchester, Exeter, and Bristol; in each whereof a public mart was appointed to be kept, and each of them had a court of the mayor of the staple, for deciding differences, held according to the law-merchant, in a summary way. The staple commodities of this kingdom are said by some to be these, *viz.* wool, leather, wool-felts, lead, tin, butter, cheese, cloth, &c. but others allow only the first five to be staple commodities.

STAPLING of Wool, the art or process of adjusting the qualities and different properties of wool in the same fleece, selecting the fine from the coarse, and placing together the more valuable parts. This is frequently called sorting.

STAR, in Astronomy, a general name for all the heavenly bodies, which are dispersed through the whole heavens.

Stars, *Falling*, in Meteorology, meteors which dart through the sky in the form of a star.

Star, in Pyrotechny, a composition of combustible matters, which being thrown aloft in the air, exhibits the appearance of a real star.

Star *Shot*, a gelatinous substance frequently found in fields, and is the half-digested food of herons, sea-mews, and the like birds; for these birds when shot have been found to disgorge a substance of the same kind.

STARBOARD, the right side of a ship when the eye of a spectator is directed forward.

Starboard, is also an order to the helmsman to put the helm a little to the starboard side; and is used only when the ship is going large or free.

STARCH. If a quantity of wheat-flour be formed into a paste, and then put under a very small stream of water, stirring it continually, till the water runs off from it colourless, the flour by this process is divided into two distinct constituents. A tough substance of a dirty white colour, called gluten, remains in the hand; the water is at first milky, but soon deposits a white powder, which is known by the name of starch.

STARLING, in Ornithology, a bird about the size of the common blackbird. The whole plumage is a resplendent black, with changeable blue, purple, copper, tints of green, and small yellow spots. During winter they assemble in large flocks. Pennant says, they may be taught to speak; and Ray observes, that they imitate the human voice much better than the parrot.

STATE, an empire, kingdom, province, or extent of country, under the same government.

STATICE, in Botany, a name now applied to the common thrift, or sea gilliflower.

STATICS, that branch of mathematics which considers the motion of bodies arising from gravity.

STATION Bill, a list containing the appointed posts of the ship's company when navigating the ship.

STATIONARY, in Astronomy, the state of a planet when it seems to remain immoveable in the same point of the zodiac.

STATIONERS. This denomination of venders of books, paper, &c. is derived from the following circumstance. The traffic of books was anciently very inconsiderable, in so much that the book merchants of England, France, and Spain, and other countries, were distinguished by the appellation of Stationers, as having no shops, but only stalls and stands in the streets.

STATISTICS, a word lately introduced to express a view or survey of any kingdom, county, or parish.

STATUARY, a branch of sculpture, employed in the making of statues. In this art the ancients are thought to have excelled the moderns. Among the former, the name of Phidias stands pre-eminent; and among the latter, that of Michael Angelo.

STATUES, are figures representing living or deceased creatures, of whatever species, real or imaginary; and carved, cast, modelled, or moulded, in full relievo, insulated on every part. Statues are formed with the chisel, of several materials, such as marble, stone, &c.: they are carved in wood, or cast in plaster of Paris, or other matter of the same nature; they are also cast in several metals, as lead, brass, silver, and gold.

STATURE, the height or pitch of a man, which is found admirably adapted to the circumstances of his existence.

STATUTE, in its general sense, signifies a law, ordinance, decree, &c. Statute, in our laws and customs, more immediately signifies an act of parliament made by the three estates of the realm; and such statutes are either public, of which the courts at Westminster must take notice, without pleading them, or they are special and private, which last must be pleaded.

Statute *Merchant*, is a bond of record acknowledged before one of the clerks of the statute merchant, and lord mayor of the city of London, or two merchants of the said city for that purpose assigned, or before the mayor or warden of the town, or other discreet men, for that purpose assigned.

Statute *Staple*, is a bond of record acknowledged before the mayor of the staple, in the presence of all or one of the constables; but now statute staple, as well as statute merchant, are in great measure become obsolete.

Statutes, or *Statute Sessions*, otherwise called *petit sessions*, is a meeting in every hundred of all the shires in England, whereto the constables and others, both holder and servants, repair for the debating of conferences between masters and servants, the rating of servants' wages, and bestowing such people in service as, being fit to serve, either refuse to seek or get masters.

STAUROLITE, in Mineralogy This stone has been found at Andresberg in the Hartz. It is crystallized, and the form of its crystals has induced mineralogists to give it the name of cross-stone. Its crystals are two four-sided flattened prisms, terminated by four-sided pyramids, intersecting each other at right angles; the plane of intersection passing longitudinally through the prism. Sometimes these prisms occur solitary. Primitive form, an octahedron with isosceles triangular faces, the faces of the crystals striated longitudinally.

STAVE, in Music, the five horizontal and parallel lines on and between which the notes are placed.

STAY, a large strong rope, employed to support the mast on the fore part, by extending from its upper end towards the stem of the ship, as the shrouds are extended on each side. The *Fore Stay*, is that which reaches from the fore-mast head towards the bowsprit end. The *Main Stay*, is that which extends to the ship's stem. The *Mizzen Stay*, is that which is stretched to a collar on the main-mast immediately above the quarter-deck. The *Fore Top-Mast Stay*, is that which comes to the end of the bowsprit, a little beyond the fore-stay. The *Main-Top-Mast Stay*, is attached to the hounds of the fore-mast. The *Mizzen Top-Mast Stay*, is that which comes to the hounds of the main-mast. The *Fore-Top-Gallant Stay*, is that which comes to the outer end of the jib-boom. The *Main-Top-Gallant Stay*, is that which is extended to the head of the fore-top-mast. The *Mizzen-Top-Gallant Stay*, is that which is attached to the head of the main-mast. The *Royal-Stays*, when used, are those which extend to the jib-boom end, or to the heads of the top, or top-gallant masts next before them. The whole of these stays are nearly in the direction of the upper edges of the several stay-sails which derive their names from them.

SPRING Stay, is a kind of assistant stay, extending in a direction nearly parallel to the principal stay, it is much thinner than the other, and is only used to the lower-masts and top-masts.

Stay-*Sail*, any sail extended upon a stay.

Stay-*Sail-Stay*, a rope used solely to extend and support a stay-sail, as the middle stay-sail.

Stay-*Tackle*, a large tackle, attached by means of a pendant to the main-stay. It is used to hoist heavy bodies, such as the boats, or butts of water, beer, &c. in or out of the ship, and out of the holds; for which purpose there are generally two, the one over the fore-hatchway, the other perpendicular to the main-hatchway; and they are accordingly distinguished by the epithets, main or fore stay-tackles, though both are upon the main-stay.

**STEADY**, at Sea, the command given to the helmsman in a fair wind, to steer the ship in the line on which she advances at that instant, without deviating from the right or left; to which the helmsman answers, "Steady," to shew his attention to the order.

**STEALING**, the fraudulent taking away another man's goods, with an intent to steal them against, or without, the will of him whose goods they are.

**STEAM**, water converted by heat into vapour.

**STEAM-ENGINE**, an engine originally contrived for raising water by means of the expansive force of the steam or vapour produced from water or other liquids in a state of ebullition.

*General Principle of the Steam Engine.*—The force of the steam-engine is derived from the property of water to expand itself in an amazing degree, when heated above the temperature at which it becomes changed into steam or vapour, which being an exceedingly elastic fluid, it can be retained within the close vessel or boiler to which the heat is applied, even when it has an expansive force sufficient to make it fill, if left at liberty, 20 or 30 times the space in which it is confined. In this state the steam will exert a proportionate force or pressure to burst open the sides of the vessel in which it is retained; which force may be applied either to expel or raise up water from any vessel into which the confined steam is admitted, or to give motion to a moveable piston, which is so accurately fitted to the interior capacity of such vessel, as not to permit the escape of the steam between them.

Another source of the power of the steam engine, is the facility with which steam of a great expansive force can be cooled by the application of cold water, and condensed into the small quantity of water from which it was originally produced. A partial vacuum can thus be made, in a very large vessel, in an instant, and even in the same vessel, which was, a moment before, filled with confined steam, exerting a great force to escape. The pressure of the atmosphere which tends to fill up this vacuum, can be made to produce the ascent of water into the vessel to any height less than twenty-four or twenty-five feet. Or the pressure of the atmosphere may be made to give motion to a piston, by admitting the atmospheric air to press upon one side of the piston, whilst there is a vacuous space formed by the condensation of the steam which filled the cylinder on the other.

Notwithstanding the great variety of different constructions of the steam-engine, they all derive their force from one of these two principles, or from the combination of the two; but before entering upon any description of the manner in which these forces are applied, it is necessary to have clear ideas of the nature of steam, and of the law by which it expands by heat, in order to form a precise judgment of what passes in the interior part of a steam-engine when it is at work. In the common acceptation of the word steam, it is that hot white vapour which we see every day rising in a cloud from a tea-kettle, or a boiling pot: but this is not exactly the state of the steam employed in an engine; it is there perfectly transparent, and is more or less hot than boiling water, according as it is retained under a lesser or greater degree of compressure. The ordinary pressure of the atmosphere, bearing upon the surface of the water, will retain it in a state of fluidity, until it is heated to what is generally called the boiling point, and is marked 212° in Fahrenheit's thermometer. If the heat is increased above that degree, and if the water is unconfined except by the pressure of the atmosphere, the water immediately assumes the aeriform state, and flies off in elastic vapour, which we call steam; but if the same water is relieved from the pressure of the atmosphere by enclosing it in a close vessel, and exhausting the air from it, a certain portion of steam or vapour will rise from the same at any temperature, even when it is as low as freezing; and if this vapour is conveyed off from the vessel as fast as it rises, the water, although cold, will boil, and such vapour will rise as fast as from the boiling kettle in the open air. If the vapour is retained in the vessel, it will only accumulate, until it has acquired a certain degree of elastic force to press upon the surface of the water, which will then cease to yield any more vapour, until the heat is farther increased, or that the vapour is drawn off to relieve the water from the pressure which confined and retained it in its fluid state. On the other hand, water which is retained in a close vessel, under a greater degree of pressure than that occasioned by the pressure of the atmosphere, will not boil or rise in vapour, until it becomes heated to a higher temperature than 212°. It is even probable, that water might be compressed to that degree, that it would not boil until heated red-hot; but this would require such an enormous strength in the vessel which should contain the steam, that it is far beyond the practicability of an experiment. In this manner the reader is to bear in mind, that vapour or steam, when confined in close vessels, is always more or less elastic, in proportion to the degree of heat which is applied to it; or, in other words, that the temperature of the steam is an exact index of the elastic or expansive force with which it presses upon the surface of the water, and against the interior surface of the vessel which contains it.

The first notice which we have of the steam-engine, is in a small pamphlet by the Marquis of Worcester, written in 1655, and published during the reign of Charles II. in 1663, entitled, "A Century of the Names and Scantlings of the Marquis of Worcester's Inventions." In the sixty-eighth article of this Century of Inventions, the author thus speaks:—"An admirable and most forcible way to drive up water by fire! not by drawing or sucking it upwards, for that must be as the philosopher calleth it, *intra spheram activitatis*, which is but at such a distance. But this way hath no bounder, if the vessel be strong enough; for I have taken a piece of a whole cannon, whereof the end was burst, and filled it three-quarters full of water, stopping and screwing up the broken end, as also the touch-hole; and making a constant fire under it, within twenty-four hours it burst, and made a great crack; so that having a way to make my vessels, so that they are strengthened by the force within them, and the one to fill after the other, I have seen the water run like a constant fountain stream forty feet high; one vessel of water, rarefied by fire, driveth up forty of cold water. And a man that tends the work is but to turn two cocks, that one vessel of water being consumed, another begins to force and refill with cold water, and so successively; the fire being tended and kept constant, which the self-same person may likewise abundantly perform in the interim between the necessity of turning the said cocks."

However plain these hints may now appear, they were thought at the time when first published, to border so much on the marvellous and romantic, as to be scarcely worthy of notice; and finally, from being neglected, they became nearly forgotten. At length, after a lapse of about forty years, Capt. Thomas Savery, a commissioner of sick and wounded, obtained a patent in 1698, for "A new invention for raising water, and occasioning motion to all sorts of millwork, by the impellent force of fire." Of this contrivance, a small model was exhibited to the Royal Society, and in vol. xxi. of their Transactions, their approbation is recorded. The inventor afterwards published an account of his engine in a small book, entitled, "The Miner's Friend," accompanied with an engraving; which shews that this early effort of genius had made a bold advance toward perfection.

It appears from Captain Savery's description, that his engine not only derived its power from the expansive force of steam, like that of the Marquis, but also by the condensation of steam, the water being first raised by the pressure of the atmosphere, to a given height from the well into the engine, and then forced out of the engine up the remaining height, by the expansive force of steam. This action was performed alternately by two receivers, so that while the vacuum formed in one, was drawing up from the well, the pressure of the steam in the other was forcing up water into the reservoir. The power and utility of Savery's engine being every where acknowledged, many improvements were subsequently made by various engineers, in its appendages, arrangements, and the adjustments of its parts; but nothing of importance appeared, to mark an era in the history of the steam-engine, until about the year 1705, when Thomas Newcomen, ironmonger, and John Cawley, glazier, of Dartmouth, obtained a patent for a new invention; but so far was their principle of movement connected with that of Savery, that the latter was admitted to a participation in their patent.

The engine thus brought into use is sometimes called the atmospheric engine, and is commonly a forcing pump, having its rod fixed to one end of a lever, which is worked by the weight of the atmosphere upon a piston at the other end, a temporary vacuum being made below it by suddenly condensing the steam that had been admitted into the cylinder in which this piston works, by a jet of cold water thrown into it. A partial vacuum being thus made, the weight of the atmosphere presses down the piston, and raises the other end of the straight lever, together with the water, from the well. Then immediately a hole is uncovered in the bottom of the cylinder, by which a fresh quantity of hot steam rushes in from a boiler of water below it, which proving a counterbalance for the atmosphere above the piston, the weight of the pump-rods, at the other end of the lever, carries that end down, and raises the piston of the steam-cylinder. The steam hole is then immediately shut, and a cock opened for injecting the cold water into the cylinder of steam, which condenses it to water again, and thus making a vacuum below the piston, the atmosphere again presses it down, and raises the pump-rods as before; and so on continually.

On this engine some considerable improvements were afterwards made by Mr. Smeaton, which though containing little that was new in principle, tended much to facilitate the progress of this mighty agent in the mechanic arts. The improvements made by Watt upon the engine of Newcomen and Cawley are first, that the elasticity of the steam itself is used as the active power in this engine; and secondly, that besides various other judicious arrangements for the economy of heat, he condenses the steam, not in the cylinder, but in a separate vessel.

In the cylinder or syringe, concerning which we have spoken, in mentioning the engine of Newcomen, let us suppose the upper part to be closed, and the piston rod to slide air tight through a collar of leathers. In this situation it is evident that the piston might be depressed by throwing the steam upon its upper surface, through an aperture at the superior end of the cylinder. But if we suppose the external air to have access to the lower surface of the piston, we shall find that steam no stronger in its elasticity than to equal the weight of the atmosphere would not move the piston at all; and consequently that this new engine would require much denser steam, and consume much more fuel, than the old engine. The remedy for this evil is to maintain a constant vacuum beneath the piston. If such a vacuum were originally produced by steam, it is certain that its permanency could not be depended on, unless the engine contained a provision for constantly keeping it up. Watt's contrivance in his simplest engine is as follows:—The steam is conveyed from the boiler to the upper part of the cylinder through a pipe, which also communicates occasionally with the lower part, and beyond that space with a vessel immersed in a trough of water; in which vessel the condensation is performed by an injected stream of cold water. This water is drawn off, not by an eduction pipe but by a pump, of which the stroke is sufficiently capacious to leave room for the elastic fluid, separated during the injection, to follow and be carried out with the injection water. Suppose now the piston to be at its greatest elevation, and the communication from the boiler to the upper as well as to the lower parts of the cylinder to be opened. The steam, under these circumstances, will pass into the whole internal part of the engine, and will drive the air downwards into the condenser, and thence through the valves of the air pump. In this situation, if the communication from the boiler to the lower part of the cylinder be stopped, and an injection be made into the condenser, a vacuum will be produced in that vessel, and the steam contained in the lower part of the cylinder and communication pipe will expand itself with wonderful rapidity towards the condenser, so that in a period of time too minute to be appreciated, the whole of the steam beneath the piston will be practically condensed. The steam which continues to act above the piston will immediately depress it into the vacuum beneath; at the same time that by connexion with the external apparatus, the piston of the air pump also descends in its barrel. When the stroke is nearly completed downwards, the requisite part of the apparatus shuts the communication with the boiler, opens that between the upper and lower parts of the cylinder and condensing vessel, and turns the injection-cock. At this very instant the piston loses its tendency to descend, because the steam presses equally on both surfaces, and continues its equality of pressure while the condensation is performed. It therefore rises; the injection is stopped; and the air-pump making its stroke suffers the injection water and a considerable part of the elastic fluid to pass through its lower valve. The vacuum is thus kept up through the whole internal capacity of the engine. As soon as the piston has reached the upper part of the cylinder, the communication to the under part of the cylinder is stopped, and that with the boiler opened, as before; the consequence of which is, that the piston again descends; and in this manner the alternations repeatedly take place. The principal augmentation of power in this engine, compared with that of Newcomen, arises from the cylinder not being cooled by the injection water, from its being practicable to use steam, which is more powerful than the pressure of the atmosphere, and from the employing of this steam both to elevate and to depress the piston. In general, these engines are worked by steam, which would support a column of four or five inches of mercury besides the pressure of the atmosphere, and sometimes more.

All the engines which were constructed before the time of Mr. Watt were employed merely for raising water, and were never used as the first movers of machinery; except indeed, that Mr. R. Fitzgerald published in the Transactions of the Royal Society, a method of converting the irregular motion of the beam into a continued rotatory motion, by means of a crank and a train of wheel-work connected with a large and massy fly, which by accumulating the pressure of the machine during the working stroke, urged round the machinery during the returning stroke, when there is no force pressing it forward. For this new and ingenious contrivance, Mr. Fitzgerald received a patent, and proposed to apply the steam engine as the moving power of every kind of machinery; but it does not appear that any mills were erected under this patent. In order to convert the reciprocating motion of the beam into a circular motion, Mr. Watt has a contrivance far more simple, as may be seen by inspecting any of the numerous engravings of his machinery.

The strides which steam is making in the economy of the country, are more gigantic and surprising than those who are domesticated at a distance from its immediate operation imagine; but the capability of the locomotive engine to travel, with ease and safety, with a weight of ninety tons in its train, at the rate of eight miles an hour, having been proved by the opening of the Darlington and Stockton rail-road, the following particulars of its powers and advantages may not be unacceptable to the reader:—The engine will travel over 25 miles seven times a day, making 175 miles a day's work, with 90 tons, consuming seven tons of small coals each day, or 42 tons per week; which, at an average cost of 7s., £14. 14s. will be the expense. One man and a boy in constant attendance, supposing the 24 hours equal to three days, will be three men and thirteen boys each day, at 16s. 6d.; this will add £5. 3s. 6d. making the total weekly expense £19. 17s. 6d. The engine will cost £600, 80 waggons £900,—giving £1500 for the entire set out. Now, 90 tons will load six boats, each of these boats will be a day in performing 20 miles; therefore 52 boats, with 52 horses, 52 men, and 52 boys, will be required to execute the transfer of 90 tons 175 miles in one day. Each horse will cost weekly one guinea, each man a guinea, and each boy 12s. forming a total weekly charge of £140. 8s. in lieu of £19. 17s. 6d. The 52 boats and horses will be worth £10,000, and requiring a considerably greater amount to keep them in repair, throwing a balance of full £7000 per annum in favour of every locomotive engine that may be used. How many may eventually be at work, it would be difficult to conjecture; but as forty would be required to work the London, Birmingham, and Liverpool, and the Manchester and Stockport lines, in all probability not less than 500 would be employed; and as the saving on every five engines would be equal to the interest of one million, the 500 would put the people yearly in possession of a sum as great as the interest of one hundred millions sterling, independently of the advantage of speed, and of the great saving of tonnage, the rail-road lines being one-third shorter than the canals in use. Finally, 1000 persons may be conveyed one mile, or one person 1000 miles, by locomotive engines, at the rate of eight miles an hour, at a cost of something less than five pence.

In addition to the improvements made by Watt on his original invention, many others are highly deserving of notice; but the

# STEAM ENGINE OF [illegible] HORSES POWER

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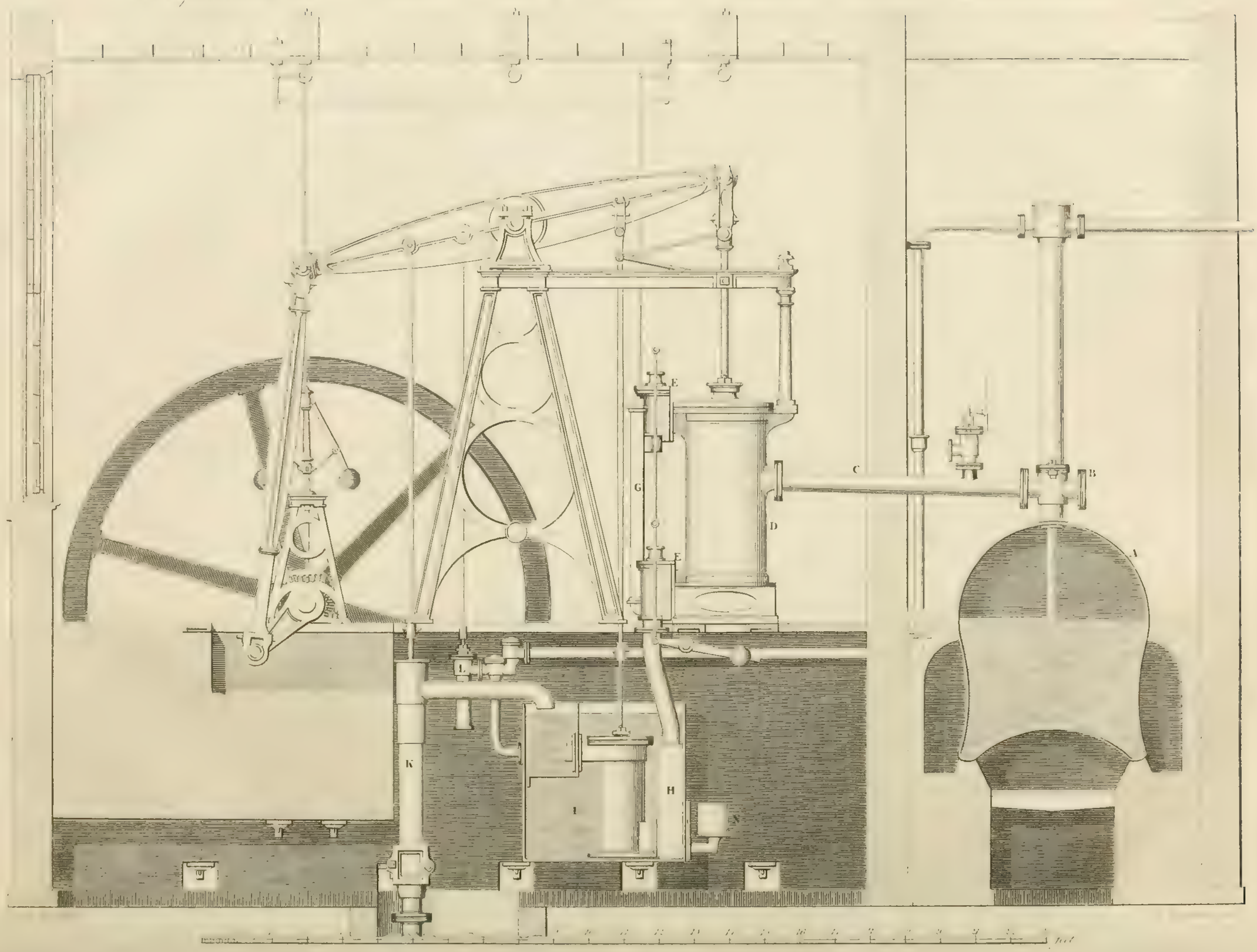

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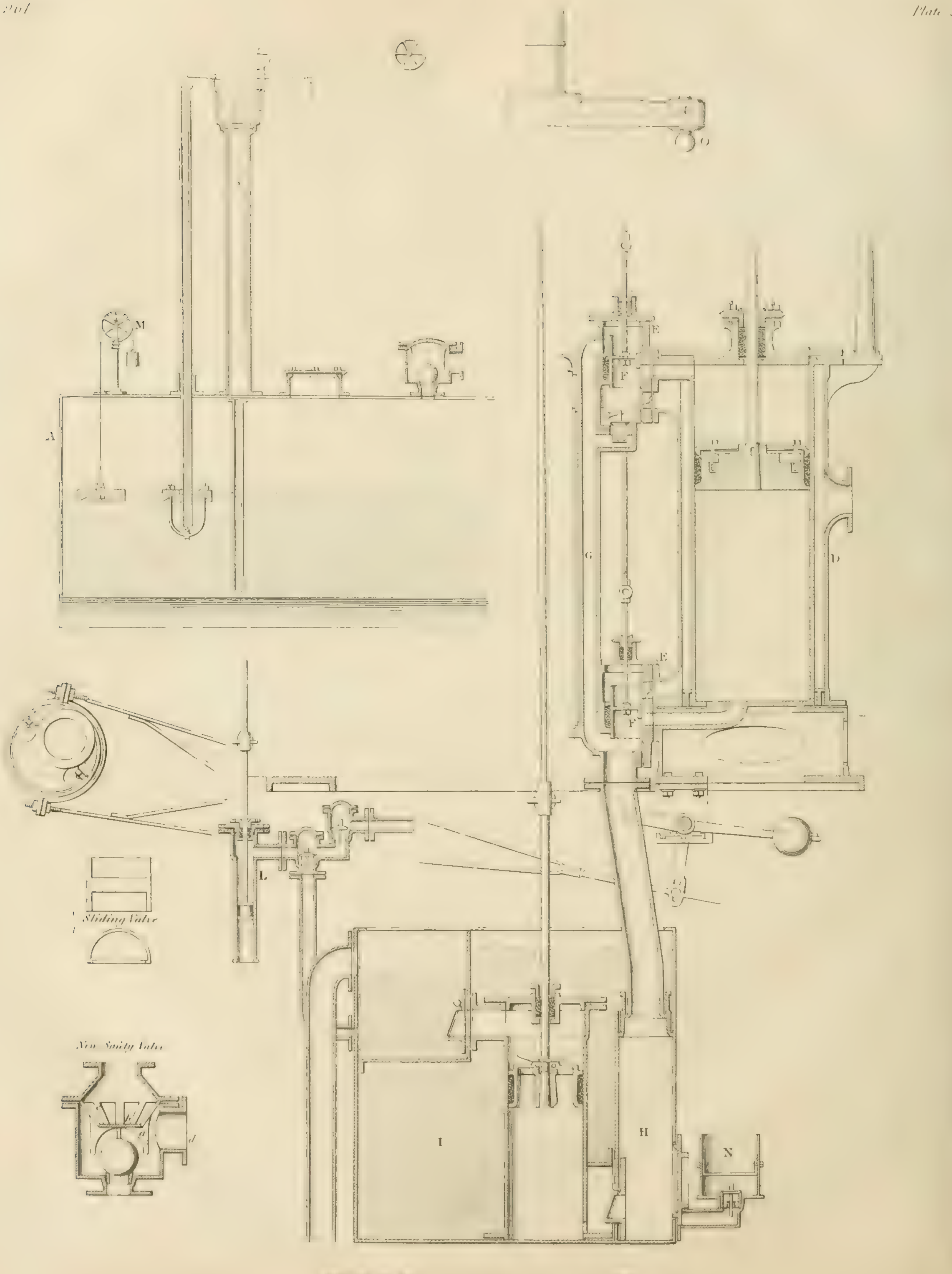
# Section of a 12 Horse Steam Engine, by Rothwell, Hick, & Rothwell, BOLTON.



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whole are too numerous to admit in detail. During the last twenty years, scarcely a month has elapsed in which some new modification has not been proposed, among which, several have been found highly beneficial. The names of Witty, Bettancourt, Moyle, Trevithick, Woolf, Evans, Perkins, and others, will never be forgotten while the steam-engine is remembered, and shall retain its use; but their respective merits we cannot find room to enumerate.

Of the steam-engine described in the following paragraphs, and illustrated in the plates, we have been furnished with an account by Mr. Hick, whose name it bears:—

" *Twelve Horse Portable Steam-Engine, as manufactured by Rothwell, Hick, and Rothwell, engineers, Bolton, Lancashire. Steam cylinder 19¼ inches diameter; 4 foot stroke; 27 strokes in a minute.*

" This engine consists, in the first place, of a large cast iron plate, firmly bolted down to stone or brick work, on which the whole of the materials are fixed. The beam, with all its appendages, is by this means supported without being at all connected with the building, by a double diagonal frame, one half only of which can be seen in the drawing. These frames are surmounted by an entablature plate, to which the bearers or spring beams are attached that receive the studs or centers of the radius rods of the parallel motion, the extreme ends of which are supported by a pillar resting on a bracket projecting from the back of the cylinder. The pedestals in which the gudgeon of the beam works, rest on the entablature plate, and are firmly secured by bolts passing through the whole. The side walls on which the foundation plate acts, are so far asunder as to allow a sufficiently wide recess to receive the condensing cistern, with its air-pump and condenser, hot and cold water pumps, as well as to afford room for getting down to secure the ends of the bolts. The governor is supported by a standard placed directly over the crank shaft, and is turned by a single pair of bevel wheels. The upper part of it is hollow, to receive a small rod that is attached by a cross pin to a brass sliding socket, which is connected with the governor arms by two small links, and partakes of the motion communicated to them by the movement of the balls. The small rod has a communication with the throttle valves, by means of the levers fixed to the ceiling of the engine-house.

" The annexed engraving represents a steam-engine of twelve horses' power, with a cross section of its boiler A, about two-thirds filled with water. The boiler is oblong, 12 feet by 5½ feet, and the flame, after acting upon the whole length of the bottom, is conducted entirely over the whole surface of the sides and ends, by means of the brick flues, (which are wide enough to admit a person to get in, to clean them when requisite,) before its entrance to the chimney.

" In the flue near to the chimney, is placed a damper or plate, moving perpendicularly in two grooves, in such a manner as entirely to stop the draft when shut. This damper is suspended by a chain passing over two pulleys, at the opposite end of which is attached a hollow iron float, that moves up or down in a pipe fixed on the top of the boiler, exactly in proportion to the height of the column of water in the pipe, that the strength of the steam is capable of supporting, which rising in height as the strength of the steam increases, raises the float, and causes the damper to descend, thereby lessening the draft, and *vice versa.* To this apparatus a bell is sometimes connected, to give notice of the time when it is necessary to throw an additional quantity of coals upon the fire.

" In order to prevent any stoppage of the engine when it might be necessary to repair a boiler, two are now generally adopted, and the box B on the boiler top, which contains a stop valve, is prepared with an additional branch, to communicate with a second boiler. On the steam pipe, and leading to the cylinder, is placed a box containing a valve opening upwards, called a safety valve, and so weighted as to rise and let the steam escape when it is stronger than the engine requires.

" The steam cylinder and its casing are cast together in one piece. A section of which, in plate 2, will explain the construction of this important part of the engine, as well as the peculiar construction of the valves for admitting the steam alternately to act on contrary sides of the piston. The space betwixt the cylinder and the casing being constantly filled with steam, prevents any condensation taking place within the cylinder, and serves also as a conducting pipe for the steam to the boxes E, containing the sliding valves, (which are generally called D valves, from their resemblance in form to that letter,) through two separate openings for that purpose, in each of which is placed a throttle valve, and on their spindles are levers communicating by a rod with the governor for the purpose of regulating the speed of the engine.

" The valves F are packed on their circular sides with a soft substance of hemp or flax, and in consequence of the steam being admitted to the *under* side of the top valve, and the *upper* side of the bottom valve, they of course require no more force to move them than what is necessary to overcome the friction of the packing and the surface over which they slide. The weight of the valves and their rods are accurately counterbalanced by a moveable weight or a lever under the cylinder, and are moved by an eccentric circle, or the fly-wheel shaft, which is shewn on an enlarged scale in plate 2. By the arrangement of having two throttle valves, the least difference in weight between those parts of the engine that are attached to the opposite ends of the working beam, can be regulated, by allowing a little more steam to pass in the same time through either of the valves, as may be found necessary, thereby equalizing as much as possible the action of the engine. One pipe, G, only is required in front of the cylinder, and that for the purpose of conducting the steam from the upper side of the piston to the condenser H,—a vessel in which the condensation of the steam is effected after its escape from the cylinder, by admitting a quantity of cold water out of the condensing cistern I, through an injection cock, the opening of which is regulated by hand. The condensing cistern is supplied with water by the cold-water pump K.

" The air pump, (or, more properly, discharging pump,) for the purpose of removing the water from the condenser after its admixture with the steam, and keeping up a constant vacuum, with its valves and bucket, will be fully understood by a reference to plate 2, as well as L, the hot-water pump, used for raising water to supply the boiler, which water passes through a small valve, and down the same pipe that contains the damper float. This valve is connected with a lever, having one of its ends connected by a rod passing through a pipe with a stone float, that rises and falls with the surface of the water in the boiler, and thereby admitting a smaller or larger quantity of water, as may be requisite. This pipe, for the rod to pass through, has several advantages over the method of passing it through a *stuffing box* on the boiler top, as in case the hot water pump by any accident should cease to act, and the water get low in the boiler, the steam would make its escape before any serious injury could happen, shewing instantly that such was the fact the moment it got below the end of the pipe. The friction between the rod and the water being so trifling, insures an almost uniform regularity of action.

" The little apparatus M, or self-acting water gauge, consists of a standard fixed on the boiler top, with a pulley, over which a chain passes connected at one end with a copper wire, and a stone float, which by its rising or falling indicates the exact variation that takes place in the height of the surface of the water, and is used in lieu of the gauge pipes and cocks formerly applied for that purpose, over which it has this great advantage, that besides shewing the water to be too high or too low, it shews exactly how much, by the pointer and scale that are affixed to it.

" N, a small cistern containing the blow valve, for the purpose of allowing the air to escape from the cylinder, &c. previous to the engine being set to work.

" The crank P in *o* is made globular, to prevent any strain in case the shaft should get out of its level position by the unequal wearing of the brass steps under its tunnels, or any little sinking of the foundation." — — — —

" In order to prevent the accidents occasioned by the bursting of steam boilers, which are of such frequent occurrence, I must now solicit a little attention to the drawing and description of a self-acting safety valve, of my invention, or rather the application of it to a new purpose; for a similar valve has been used as a clack for a pump upwards of a hundred years; and it will easily be perceived from the several advantages it possesses, that wherever its adoption shall take place it will be scarcely possible for any accident of this nature to arise.

"The opening in the lower part of the box, which is fixed on the boiler top, or, if more convenient, on any part of a pipe having a free communication with it, requires to be of such a size as to allow a free discharge of all the steam the boiler is capable of generating. This opening is covered with a spherical valve, the outer part of brass, which is filled with lead, of such dimensions, and consequently of such weight, as to press with as many pounds per square inch, as it is intended the strength of the steam at a *maximum* in the boiler should ever be raised to. Now, as it is perfectly free from friction, the obvious effect will be, that at the very instant the steam arrives at this degree of pressure, the ball will be raised by its force, and a discharge will immediately take place.

"The plate *b*, which is large enough to cover entirely the ball or valve, and thereby prevent its being pressed down, or at all interfered with, even by any bar or rod being forced down the discharging pipe, is connected with the cover by small bars *c*. The projections *a* are merely to prevent the ball at any time from being thrown off its seat. Originally the steam was discharged at the side-opening *d*, but this will be rendered unnecessary if the plan be adopted which has the discharging pipe in the lid or cover of the box, but both are drawn to shew the different methods of taking away the steam, and the selection must be made according to convenience, and the judgment of the engineer.

"From the nature of its construction, this safety valve, requiring no packing or attention, can be entirely secured from the officious meddling and carelessness of attendants; and a pipe may be attached to the opening in the box, and continued into the chimney, or any other convenient place of discharge. I should not recommend this valve to be used as a substitute for the ordinary safety valve, (improperly so called,) but in all cases in addition, and so loaded as only to be brought into action at a very trifling additional pressure above that to which the other valve is weighted. This valve would be found of the greatest advantage, in preventing the boiling over of the feed pipes of boilers, when the rooms over them are used as drying stoves in print-works, bleach-works, &c. I ought to state, that I have had this description of valve in use upwards of four years, with the greatest regularity of action."

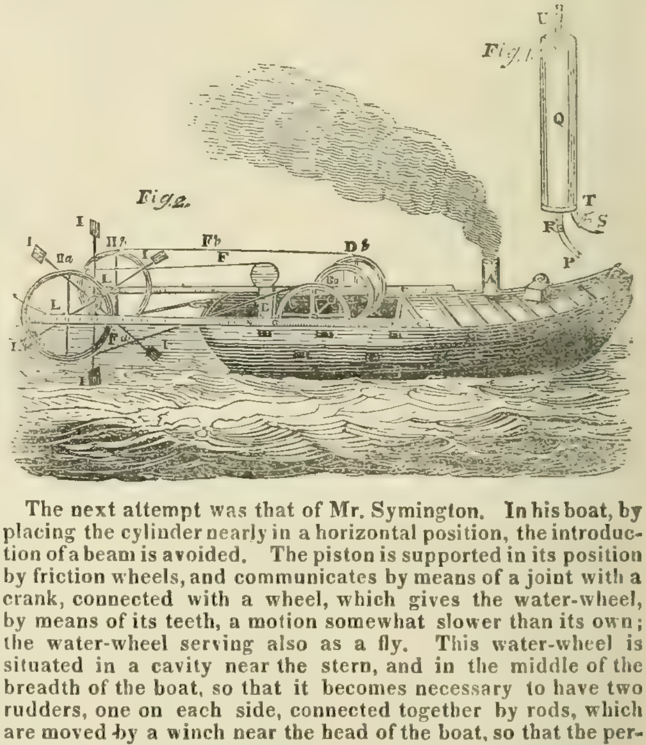
*First Steam Boat.*—Although it is only of late years that steam has been extensively applied to the propelling of vessels on water, yet, a knowledge of its capabilities for this purpose is of old date. As far back as the 21st of December 1736, Mr. Jonathan Hulls took out a patent for "A new-invented Machine for carrying Vesssels or Ships out of, or into, any Harbour, Port, or River, against Wind and Tide, or in a Calm;" and in the following year, he published a pamphlet in London, detailing at length the nature of his invention, which was nothing else than a tow-boat moved by steam, as represented in the annexed engraving. The description of the mode of working it we shall give in his own words

In some convenient part of the tow-boat, there is placed a vessel, about two-thirds full of water, with the top close shut. This vessel being kept boiling, rarefies the water into a steam. This steam being conveyed through a large pipe into a cylindrical vessel, and there condensed, makes a vacuum, which causes the atmosphere to press on this vessel, and so presses down a piston that is fitted into the cylindrical vessel, in the same manner as Mr. Newcomen's engine with which he raises the water by fire.

"Fig. 1, P, is the pipe coming from the furnace to the cylinder. Q, is the cylinder wherein the steam is condensed. R, the valve that stops the steam from coming into the cylinder whilst the steam within the same is condensed. S, the pipe to convey the condensing water into the cylinder. T, a cock to let in the condensing water when the cylinder is full of steam, and the valve P is shut. U, a rope fixed to the piston that slides up and down the cylinder.

"*Note.*—This rope U is the same rope that goes round the wheel D in the machine fig. 2.

"Fig. A the chimney coming from the furnace. B the tow-boat. C C two pieces of timber, framed together to carry the machine. D *a* D and D *b* are three wheels on one axis, to receive the ropes M *f l* and F *a*. H *a* and H *b* are two wheels on the same axis with the fans I I I I I I, and move alternately in such a manner, that, when the wheels D *a* D and D *b* move backward or forward, they keep the fans in a direct motion. F *f* is a rope going from H *b* to D *b*, that when the wheels D *a* D and D *b* move forward, moves the wheel H *b* forwards, which brings the fans forward with it. F *a* is a rope going from the wheel H *a* to the wheel D *a*, that, when the wheels D *a* and D *b* move forward, the wheel H *a* draws the rope F, and raises the weight G, at the same time as the wheel H *b* brings the fans forward. When the weight G is so raised, while the wheels D *a* D and D *b* are moving backward, the rope F *a* gives way, and the power of the weight G, brings the wheel H *a* forward and the fans with it, so that the fans always keep going forward, notwithstanding the wheels D *a* D and D *b* move backwards and forwards as the piston moves up and down in the cylinder. L L are teeth for a catch to drop in from the axis, and are so contrived, that they catch in an alternate manner to cause the fans to move always forward for the wheel H *a*, by the power of the weight G, is performing its office, while the other wheel H *b* goes back in order to fetch another stroke."



The next attempt was that of Mr. Symington. In his boat, by placing the cylinder nearly in a horizontal position, the introduction of a beam is avoided. The piston is supported in its position by friction wheels, and communicates by means of a joint with a crank, connected with a wheel, which gives the water-wheel, by means of its teeth, a motion somewhat slower than its own; the water-wheel serving also as a fly. This water-wheel is situated in a cavity near the stern, and in the middle of the breadth of the boat, so that it becomes necessary to have two rudders, one on each side, connected together by rods, which are moved by a winch near the head of the boat, so that the person who attends the engine may also steer. Mr. Symington likewise placed an arrangement of stampers at the head of the boat, for the purpose of breaking the ice on canals, an operation often attended with great labour and expense. These stampers were raised in succession by levers, the ends of which were depressed by the pins of wheels turned by an axis communicating with the water-wheel. A drawing of this steam-boat is given in vol. i. of Dr. Young's Natural Philosophy.

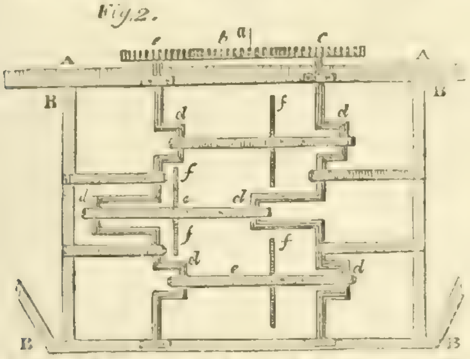
The first steam-boat in America was launched at New York on the 3d of October 1807, and began to ply on the river between that city and Albany, a distance of about 120 miles.

In the common wheel paddles at present employed for propelling steam-boats, "there are, it appears to me, (says Mr. Clark,) two defects, which are yet left to the ingenuity of the mechanic to remove. In the first place, they are defective, on account of the declivity with which they enter and come out of the water. In the second place, the successive paddles are commonly placed so very near one another, that when one paddle enters the water, it leaves, by its swift motion, a current, into which the next paddle enters; which, instead of moving in an opposite direction to the paddles, moves in the same. Great resistance is thus lost. To remedy the former of these defects, several attempts have been made in this country. These attempts, however, have commonly been unsuccessful, on account of the great contingency of force which steam-boat paddles are called to bear. The latter of the defects which I have stated, has not, however, so far as I am aware, met the attention of the mechanics of this country.

"About two years ago, I made some attempts at the removal of these defects. The following is an account of one of the plans which occurred to me.

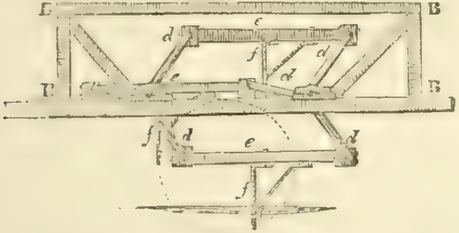
"Fig. 2 is a plan of the machine; fig. 3 is a sectional view. The same letters refer to both. A A fig. 2, is the side of the boat. B B, B B, figs. 2 and 3, is the frame to support the machinery.

Fig. 2.



*a* is the shaft which turns the wheel *b*, whose teeth run into those of the wheels *c c*, and turn both in the same direction. These wheels are connected, by a shaft, with the double cranks *d d d*, *d d d*. These cranks are inclined to one another, at equal angles, and are of equal lengths. *e e e* are bars, connecting these cranks in such a manner as to preserve the corresponding cranks on the different shafts, parallel to one another, as shewn in fig. 3, *f f f* are paddles affixed perpendicularly to these bars. These paddles alone, or the paddles and the bars together, may be so fixed as to be removable at pleasure."

Fig. 3.



From this description, it is evident that the cranks on the same shaft will always preserve the same inclination to one another; that the corresponding ones on different shafts will always be parallel; that the bars connecting them will always be horizontal; and consequently that the paddles must always enter, pass through, and rise out of the water, perpendicularly to its surface. The terminations of the paddles move in a circle, as represented in fig. 3 by a dotted line. The radius of this circle is equal to the length of any of the several cranks. It is evident, also, that every successive paddle enters in a current different from that caused by the one which it follows.

Of an excellent plan for the consuming of smoke, invented by Mr. Chapman, of Whitby, and for which he was rewarded with the large silver medal by the Society of Arts, the following is his account:—

"It is well known to all that are conversant on the subject, that it is necessary to admit a proportion of pure atmospheric air, to unite with the smoke after it is generated in the furnace, in order to supply the oxygen gas, without which it will not inflame. It is likewise known that any air admitted into the body of the furnace, if it does not go through the burning fuel, has a great tendency to cool the bottom of the boiler, and retard the generation of steam. To obviate this, it is the general practice, in the construction of those furnaces which consume the smoke, to admit the air partly at the ash-pit, and partly up through the fire-bridge. I offer, for the consideration of the Society, an improved plan, which I have adopted, and which has answered beyond my utmost expectations. It is as follows:—

"To heat the air before its admission into the furnace. This I do by casting the grate bars hollow from end to end, so that they form a series of parallel tubes, which open in two boxes, one placed in front, and the other behind the grate. In the front box, directly under the fire-door, I make a register to open and shut, to any extent, at pleasure. The other end I connect with the brickwork directly underneath the fire-bridge, which fire-bridge I make double, with a small interval between, say one inch; the interval to go across the furnace from side to side, and rather to incline forward, or towards the fire-door, so as to meet and reverberate the smoke on to the ignited fuel in the grate, which causes it to inflame and become a sheet of bright fire under the bottom of the boiler. From what I have said it will appear, that if the front register is open, or partially so, there will be a great draught of air through it, along the interior of the grate bars, thence into the flue of the fire-bridge, and out of the orifice at top, which air will be heated in its passage through the bars, before it comes in contact with the smoke, when it will give out its oxygen, and cause it to inflame.

"Such was my view of this part of the subject in theory, and I have found it to succeed in practice, in a small engine of my own. But a further improvement was necessary to make it quite perfect. There are few people who are aware of the extent of the mischief arising from the old method of charging a grate by the front door. Now, in my engine, (which has only two-horse power), I calculated that every time the fire-door was opened, to stir the fire and replenish the fuel, there could not be less than from forty-five to fifty feet of cold atmospherical air admitted into the furnace, which so cooled the heated gases, &c. that, however complete the plan was in other respects, the smoke could not possibly inflame, from being so cooled, till a considerable time after the fire-door was shut.

"To obviate this, I have adopted a cast iron hopper above the fire-door, with a type at the bottom, that has two pivots at one side and open at the other; one pivot goes through the end of the hopper, and has a counter-lever to keep the type shut when a sufficient quantity of coal for a charge is on it. The top of the hopper is covered with a lid, which I shut down during the time of firing, then, by lifting the lever which opens the type inside, the coals slide down on to the fore end of the grate bars, which is only the work of a moment. It is evident that no quantity of cold air can thus get into the furnace; in fact, it is not possible for any person that does not see the operation of firing to know when fresh fuel is added by looking at the top of the chimney. The smoke that issues is never more than a light gray, just perceptible, but in a general way is not seen at all.

"The coals last admitted, after lying a short time at the front of the more ignited fuel, become partially coked, and just before I admit a fresh supply, I push the last charge further along the grate, by a tool made for the purpose, which remains constantly in the furnace. It consists of a plate of iron about four inches broad; its length goes across the grate with a round bar of iron riveted into its centre, at right angles, to form a handle, which comes through a hole made at the bottom of the fire-door, and is long enough for a man to use with both hands, so that he can either push from, or pull towards him, to manage the fire within, without opening the fire door, except when the grate wants cleaning, &c. &c. For better knowing when the fire wants stirring or replenishing, I have a hole, about an inch in diameter, in the fire door, to look through, covered by a piece of iron which hangs by a rivet above. After I have used the above instrument, I pull it up close to the fire-door, where it remains till it is again wanted; and the coals, when let into the fire, fall down beyond it.

"The above-written account constitutes the whole of my improvements, as far as is required by the Society, but not the whole of the advantages gained by my invention. For instance, the durability of the grate bars by the admission of air through them. I may add, that I examined my own yesterday, and I do not find them any worse, although they have been in use for four months."

STEAM PRINTING. *See* Printing by Steam.

STEATITES, in Mineralogy, is usually amorphous, but sometimes crystallized in six-sided prisms. Its texture is commonly earthy; specific gravity 2·61 to 2·79; feels greasy; seldom adheres to the tongue; colour white or gray, with a tint of other colours; the foliated green.

STEEL, a most valuable metal, consisting of iron combined with carbon. It is chiefly used for edge-tools, and other sharp and cutting instruments where hardness is required; and from the fine polish of which it is susceptible, it is used in ornaments of various kinds. By heating steel to redness, and cooling it suddenly, it can be made much harder than any other metal; and if heated to a lower temperature than redness, and suddenly cooled, it becomes the most elastic of all the metals.

STEELING, in Cutlery, the laying on a piece of steel upon a larger mass of iron, that the part which is to receive the edge, may be harder than the rest.

STEELYARD, a kind of balance, called also the Roman balance, by means of which the gravities of different bodies are found by a single weight being placed on the lever or beam, so as to secure an equilibrium; the notches and figures marked on it, denoting the number of pounds.

Steelyard *Spring*, a kind of portable balance, serving to weigh any article not exceeding forty pounds. It is composed of a brass tube, in which is a rod, round which is wound a spring of tempered steel, in a spiral form. On this rod are marked pounds, and the divisions of pounds, and to the part of the rod at the bottom of the tube, is a hook, on which the article to be weighed, is fastened. Now, the other part of the rod being made fast to the spiral spring, it must be obvious that the greater the weight which is attached to the hook, the more will the spring be pressed and contracted; and consequently the greater will be the part of the rod drawn out of the tube, on which are marked the number of pounds that have thus drawn it out.

STEEPLE, an appendage to a church, generally raised at the western end, for ornament, and also to hold the bells. Both towers and spires come under the denomination of steeple.

STEERAGE, an apartment before the great cabin, from which it is separated by a partition or bulk-head. In merchant-ships it is generally the habitation of the inferior officers and crew; but in ships of war it serves only as a hall or antichamber to the great or captain's cabin. *Steerage*, is also used to express the effort of the helm. *Steerage-Way*, implies a sufficient degree of motion communicated to a ship for her to become susceptible of the effects of the helm in governing her course.

STEERING, may be defined the art of directing a ship's way by the movements of the helm, or of applying its efforts to regulate her course when she advances. The perfection of steering, consists in a vigilant attention to the motion of the ship's head, so as to check every deviation from the line of her course in the first instant of its motion, and in applying as little of the power of the helm as possible. By this she will run more uniformly in a straight path, as declining less to the right and left; whereas, if a greater effort of the helm is employed, it will produce a greater declination from the course, and not only increase the difficulty of steering, but also make a crooked and irregular track through the water. The phrases used in steering a ship vary according to the relation of the wind to her course. Thus, if the wind is fair or large, the phrases used by the pilot or officer who superintends the steerage, are Port, Starboard, and Steady. The first is intended to direct the ship's course further to the right, the second is to guide her further to the left, and the last is designed to keep her exactly in the line on which she advances, according to her prescribed course. The excess of the first and second movement is called Hard-a-Port, and Hard-a-Starboard; the former of which gives the greatest possible inclination to the right, and the latter an equal tendency to the left. If, on the contrary, the wind is foul and scant, the phrases then used are Luff, Thus, and No-Near. The first of which is the order to keep her close to the wind; the second, to retain her in her present situation; and the third, to keep her sails full. In ships of war, the duties of conning and steering are divided amongst the quarter-masters, their mates, and the most expert seamen, who attend the helms in turns. The steerage is constantly supervised by the quarter-masters. In merchant-ships, every seaman takes his turn in steering, being directed therein by the mate of the watch, or some other officer. As the safety of a ship, and all contained therein, depend in a great measure on the steerage and effects of the helm, the apparatus by which it is managed should often be examined by the proper officers. Indeed, when the fatal effects which may result from negligence in this important duty are duly considered, such inattention must be pronounced unpardonable.

STEERSMAN, the helmsman, or timoneer; which latter appellation is derived from the French term, which signifies an helmsman. He is reckoned the best steersman who uses the least motion in putting the helm over to and again, and who keeps the ship best from making yaws, that is, from running in and out. For this purpose, he should diligently watch the movements of the head by the land, clouds, moon, or stars; because, although the course is in general regulated by compass, the vibrations of the needle are not so quickly perceived, as the sallies of the ship's head to the right or left, which, if not immediately restrained, will require additional velocity in every instant of their motion, and demand a more powerful impulse of the helm to reduce them; the application of which will operate to turn her head as far on the contrary side of her course.

STEEVING, the angle of elevation which a ship's bowsprit makes with the horizon.

STEM, a circular piece of timber, into which the two sides of a ship are united at the fore end; the lower end of it is scarfed to the keel, and the bowsprit rests upon its upper end; the ends of the wales and planks of the sides and bottom are let into a groove or channel cut in the middle of its surface, from top to bottom. The outside of the stem is usually marked with a scale of feet, answering to a perpendicular from the keel. Its use is to ascertain the draught of water at its fore part, when the ship is in preparation for a sea voyage, &c. The stem at its lower end is of equal breadth and thickness with the keel, but it grows proportionally broader and thicker towards its upper extremity. *False Stem*, is that fixed before the right one. When a ship's stem is too flat, so that she cannot keep a wind well, they put a false stem above, which makes her rid more way, and bear a better sail. *To Stem a Tide*, to acquire a velocity in sailing against the tide equal to the force of the current. *From Stem to Stern*, from one end of the ship to the other.

STEM. *See* Stalk.

STEMMATA, in the history of insects, are three smooth hemispheric dots, placed generally on the top of the head, as in most of the hymenoptera and other classes.

STEMSON, an arching piece of timber fixed within the apron, to reinforce the scarf thereof, in the same manner as the apron supports the scarf of the stem.

STENOGRAPHY. The art of short-hand writing. The following scheme is that which has received most general approbation from its simplicity, and being founded on rational principles, by which it is easily acquired and retained.

*Rules for Orthography in Short Hand.*—All quiescent consonants in words are to be dropped; and the orthography to be directed only by the pronunciation; which being known to all, will render this art attainable by those who cannot spell with precision in long hand. 2. When the absence of consonants not entirely dormant can be easily known, they may often be omitted without the least obscurity. 3. Two, or sometimes more consonants, may, to promote greater expedition, be exchanged for a single one of nearly similar sound, and no ambiguity as to the meaning ensue. 4. When two consonants of the same kind or same sound come together, without any vowel between them, only one is to be expressed; but if a vowel or vowels intervene, both are to be written; only observe, if they are perpendicular, horizontal, or oblique lines, they must only be drawn a size longer than usual; and characters with slopes must have the sides of their heads doubled.

Might is to be written mit, fight, fit, machine, mashin, enough, enuf, laugh, laf, prophet, profet, physics, fisiks, foreign, foren, sovereign, sovren, psalm, sam, receipt, reset, write rite, island, iland. In short, all that the short-hand writer has to do with orthography, is to produce the clear and distinct sound of his word in the shortest and most compact manner possible.

1. Vowels, being only simple articulate sounds, though they are the connectives of consonants, and employed in every word and every syllable, are not necessary to be inserted in the middle of words; because the consonants if fully pronounced, with the assistance of connexion, will always discover the meaning of a word, and make the writing perfectly legible. 2. If a vowel is not strongly accented in the incipient syllable of a word, or if it is mute in the final, it is likewise to be omitted; because the sound of the incipient vowel is often implied in that of the first consonant, which will consequently supply its place. 3. But if the vowel constitutes the first or last syllable of a word, or is strongly accented at its beginning or end, that vowel is continually to be written. 4. If a word begin or end with two or more vowels, though separated, or when there is a coalition of vowels, as in diphthongs and triphthongs, only one of them is to be expressed, which must be that which agrees best with the pronunciation. 5. In monosyllables, if they begin or end with a vowel, it is always to be inserted, unless the vowel *e* is mute at the end of a word.

The short-hand alphabet consists of 18 distinct characters, taken from lines and semicircular curves; the formation and application of which we shall now explain, beginning with the vowels. For the three first vowels *a*, *e*, and *i*, a comma is appropriated in different positions; and for the other three *o*, *u*, and *y*, a point. The comma and point, when applied to *a* and *o*, is to be placed as in the plate, at the top of the next character; when for *e* and *u* opposite to the middle; and when for *i* and *y* at the bottom. Simple lines may be drawn four different ways perpendicular, horizontal, and with an angle of about 45 degrees to the right and left. An ascending oblique line to the right, which will be perfectly distinct from the rest when joined to any other character, may likewise be admitted. These characters being the simplest in nature, are assigned to those five consonants which most frequently occur, *viz*, *l*, *r*, *t*, *c* hard, or *k*, and *c* soft, or *s*. Every circle may be divided with a perpendicular and horizontal line, so as to form likewise four distinct characters. These being the next to lines in the simplicity of their formation, we have appropriated them for *b*, *d*, *n*, and *m*.

The characters expressing nine of the consonants are all perfectly distinct from one another; eight only remain which are needful, *viz*. *f*, *g*, or *j*, *h*, *p*, *q*, *v*, *w*, and *x*, to find characters for which we must have recourse to mixed curves and lines. The characters which we have adopted are the simplest in nature after those already applied, admit of the easiest joining, and tend to preserve lineality and beauty in the writing. It must be observed, that we have no character for *c* when it has a hard sound as in castle, or soft as in city; for it naturally takes the sound of *k* or *s*, which in all cases will be sufficient to supply its place. *R* likewise is represented by the same character as *l*; only with this difference, *r* is written with such an ascending stroke, and *l* with a descending: which is always to be known from the manner of its union with the following character; but in a few monosyllables where *r* is the only consonant in the word, and consequently stands alone, it is to be made as is shewn in the alphabet, for distinction's sake. *Z*, as it is a letter seldom employed in the English language, and only a coarser and harder expression of *s*, must be supplied by *s* when ever it occurs; as for Zedekiah, write Sedekiah, &c.

4. The terminative character for tion, sion, cion cian, tian, is to be expressed by a small circle joined to the nearest letter and turned to the right. 5. The terminative character for *ing* is to be expressed likewise by a small circle but drawn to the left hand, and its plural *ings* by a dot. 6. The plural sign *s* is to be added to the terminative characters when necessary. 7. The separated terminations are never to be used but in polysyllables, or in words of more syllables than one.

The following is the explanation of the different arbitraries and abreviations in the plate:—No. 1, As—2, Nation—3, Thing—4, Circumstance—5, Counterfeit—6, Visible—7, Himself—8, Themselves—9, Atonement—10. Therefore—11, Christ—12, Multitude—13, Descendants—14, Government—15, Everlasting.

The most usual abbreviation, is to use the full letter of a word with a dot under it, to shew it is an abbrevation.

STEP, a block of wood fixed on the decks or bottom of a ship, and having a hole in its upper side fitted to receive the heel of a mast or capstan. *To Step a Boat's Mast*, is to erect and secure it in readiness for setting sail.

STEREOGRAPHY, the art of drawing the forms and figures of the solids upon a plane.

STEREOMETRY, that part of geometry which teaches how to measure solid bodies, that is, to find the solidity or solid contents of bodies, as globes, cylinders, cubes, vessels, ships, &c.

STEREOTYPE PRINTING. The mode of stereotype printing is first to set up a page, for instance, in the common way, and when it is rendered perfectly correct, a cast is taken from it, and in this cast the metal for the plate is poured: the plates thus procured are afterwards worked on blocks in the common way.

STERILITY, the state of that which is barren, whether animal or vegetable, in opposition to fecundity or fruitfulness.

STERLING. A pound, shilling, or penny, sterling, signifies as much as a pound, shilling, or penny, of lawful money of Great Britain as settled by authority.

STERN, the posterior part of a ship, or that part which is presented to the view of a spectator, placed on the continuation of the keel, behind. The stern is terminated by the taffarel above, and by the counters below. It is limited on the sides by the quarter-pieces, and the intermediate space comprehends the galleries and windows of the different cabins.

Stern-*Fast*, a rope used to confine the stern of a ship, lighter, or boat, to any wharf or jetty-head, &c.

Stern-*Frame*, the several pieces of timber which form the stern.

Sternmost, implies any ship or ships that are in the rear or farthest astern, as opposed to headmost.

Stern-Post, a long straight piece of timber, erected on the extremity of the keel, to sustain the rudder, and terminate the ship behind. It is usually marked like the stem with a scale of feet, from the keel upwards, in order to ascertain the draught of water abaft. This piece ought to be well served and supported, because the ends of all the lower planks of the ship's bottom are fixed in a channel cut on its surface, and the whole weight of the rudder is sustained by it. The difficulty of procuring a stern-post of sufficient breadth in one piece, has introduced the practice of fixing an additional piece behind it, which is strongly bolted to the former; the hinges which support the rudder are accordingly fixed to this latter, which is also tenoned into the keel, and is denominated the back of the post. The stern-post is strongly attached to the keel by a knee, of which one branch extends along the keel, being scarfed to the dead-wood, and fore-locked under the keel, whilst the other branch inclines upwards, and corresponds with the inside or fore part of the stern-post, to which it is also bolted in the same manner.

Stern-*Sheets*, that part of a boat which is contained between the stern and the aftmost seat of the towers. It is generally furnished with seats to accommodate passengers.

Stern-*Way*, the movement by which a ship retreats or goes backward with her stern foremost.

STERNA, the *Tern*, in Natural History, a genus of birds of the order anseres. There are twenty-five species. The following are the principal: S. caspia, or the Caspian tern. This abounds on the seas wherein it derives its name. It fishes also in rivers, and sometimes suddenly darts upon its prey from a considerable height, and at other times skims the surface of the water in the manner of a swallow. It is nearly two feet in length. It lays only two eggs, and its sound resembles those of a person laughing.—The noody, is a foot and a quarter long, and is frequently met with at sea, between the tropics.—The great tern, is found in various parts of Europe, and in summer on the British coasts. It is fourteen inches long. Its manners on the water resemble those of the swallow by land.

STEWARD, in Naval affairs, is an officer in a ship of war, appointed by the purser to distribute the different species of provisions to the officers and crew, for which purpose he is furnished with several assistants. He is generally denominated the purser's steward, or the ship's steward, to distinguish him from the captain's or the ward-room stewards, who are appointed to take care of the sea-stock belonging to the captains and lieutenants, &c.

STEWARD, a man appointed in a place or stead, and always signifies a principal officer within his jurisdiction.

STICK, GOLD. An officer of superior rank in the life-guards, so called, who is in immediate attendance upon the king's person. When his majesty gives either of his regiments of life-guards to an officer, he presents him with a gold stick. The colonels of the two regiments wait alternately month and month. The one on duty is then called gold stick in waiting, and all orders relating to the life-guards are transmitted through him. During that month he commands the brigade, receives all reports, and communicates them to the king. This temporary command of the brigade does not, however, interfere with the promotion that may be going forward, as each colonel lays those of his own particular corps before his majesty. Formerly the gold stick commanded all guards about his majesty's person. On levees and drawing room days, he goes into the king's closet for the parol.

STICK, *Silver*. The field-officer of the life-guards when on duty is so called. The silver stick is in waiting for a week, during which period all reports are made through him to the gold stick; and orders from the gold stick pass through him to the brigade. In the absence of the gold stick, on levees and drawing-room days, he goes into the king's closet for the parol.

STIFF, the quality by which a ship is enabled to carry a sufficient quantity of sail without oversetting.

STIGMA, in Entomology, a spot or anastomosis in the middle of the wings of insects, near the anterior margin, conspicuous in the hymenopterous tribes.

STIGMATA, in Natural History, the apertures in different parts of the bodies of insects, communicating with the tracheæ or air-vessels, and serving for the office of respiration.

STILL, the name of an apparatus used in distillation. *See* DISTILLATION.

STIMULANT, in Medicine, any agent which has the property of increasing the mobility, or of exciting the motions of the living body, or its moving parts.

STING, an apparatus in the body of certain insects, in form of a little spear, serving them as a weapon of offence.

STINK-POT, an earthen jar, charged with powder, grenades, and other materials of an offensive and suffocating smell. It is sometimes used by privateers, to annoy an enemy whom they design to board. See the article BOARDING.

STIPPLING, a mode of engraving on copper by means of dots, as contradistinguished from a course of continued lines.

STITCH, in Agriculture, a ridge or butt in a field which is under the plough. The dimensions of a stitch are liable to many variations in different districts.

STOAT, in Zöology, the name of an animal whose skin is the ermine. These creatures are plentiful in Russia and Norway, where an extensive trade in their skins is carried on. Their fur changes colour with the seasons of the year. When the snow is on the ground, its celebrated whiteness appears to the greatest advantage.

STOCK, generally implies provisions procured by individuals, for the particular accommodation of themselves or messmates; hence we say, fresh stock, sea stock, live stock.

STOCKINGS, the clothing of the leg and foot. Anciently stockings were made of cloth or milled stuff sewed together, but since the knitting and weaving of stockings have been invented, cloth has been entirely laid aside. Henry II. of France, in 1559, was the first who wore silk stockings. Henry VIII. and Queen Elizabeth, were the first who wore silk stockings in England, and these were brought from Spain, where the invention seems to have had its birth. In the third year of Elizabeth, the art of knitting was introduced into England, and to this honour the Scotch lay claim. The stocking loom is generally thought to have been invented by William Lee, M. A. of St. John's College, Cambridge, a native of Woodborough, near Nottingham, in the year 1589; but receiving little encouragement, and being in indigent circumstances, he went to France, where, meeting with further disappointment, he died of a broken heart.

STOCKS, a frame erected on the shore of a river, whereon to build shipping. It generally consists of a number of wooden blocks ranged parallel to each other at convenient distances, and with a gradual declivity towards the water.

STOCKS, the public funds of the nation, instituted for the purpose of paying the interest upon loans.

STOCKS, a wooden machine to put the legs of offenders in, for the securing of disorderly persons, and by way of punishment in divers cases ordained by statute, &c.

STOLE, GROOM OF THE, the eldest gentleman of his majesty's bed-chamber, whose office and honour it is to present and put on his majesty's first garment, or shirt, every morning, and to order the things into the chamber.

STONEHENGE, a stupendous monument, of Druidical antiquity, standing on Salisbury plain, and supposed to be nearly coeval with the pyramids of Egypt. Its origin and use are buried in impenetrable obscurity.

STONES and EARTHS. The only substances which enter into the composition of the simple stones, as far at least as analysis has discovered, are the six earths, silica, alumina, zirconia, glucina, lime, and magnesia; and the oxides of iron, manganese, nickel, chromium, and copper. Seldom more than four or five of these substances are found combined together in the same stone.

STONE-*Ware*. Under the denomination stone-ware are comprehended all the different artificial combinations of earthy bodies which are applied to useful purposes.

STOP, in Music, a word applied by violin and violincello performers, to that pressure of the strings by which they are brought into contact with the finger-board, and by which the pitch of the note is determined.

STOP, *Trumpet*, a reed metallic stop, so called because its tone is imitative of the trumpet.

STOPPER, of the Anchor, a strong rope attached to the cat-head, which, passing through the anchor-ring, is afterwards fastened to a timber-head, thereby securing the anchor on the bow. *Stoppers*, of the cables, commonly called deck-stoppers, have a large knot and a laniard at one end, and are fastened to a ring-bolt in the deck by the other; they are attached to the cable by the laniard, which is fastened securely round both by several turns passed behind the knot, or about the neck of the stopper, by which means the cable is restrained from running out of the ship when she rides at anchor. *Dog-Stoppers*, is a strong rope clenched round the main-mast, and used on particular occasions to relieve and assist the preceding when the ship rides in a heavy sea, or otherwise bears a great strain on the cable. *Wing-Stoppers*, similar pieces of rope clenched round one of the beams near the ship's side, and serving the same purpose as the preceding. *Stoppers* of the rigging, have a knot and a laniard at each end; they are used when the shrouds, stays, or back-stays, are cut asunder in battle, or disabled in tempestuous weather, and are then lashed, in the same manner as those of the cables, to the separated parts of the shroud, &c. which are thereby reunited so as to be fit for immediate service. This, however, is only a temporary expedient, applied when there is not time or opportunity to refit them by a more complete operation. *Stoppers*, are also pieces of rope used to prevent the running rigging from coming up whilst being belayed.

STOPPERS, certain short pieces of rope, which are usually knotted at one or both ends, according to the purpose for which they are intended.

STORAX, in the Materia Medica, is the resinous drug which issues in a fluid state from incisions made in the bark or branches of the storax tree. It can be obtained in perfection only from those trees which grow in Asiatic Turkey.

STORE-KEEPER, an officer invested with the charge of the principal stores. *Store-Room*, an apartment or place of reserve, of which there are several in a ship, to contain the provisions or stores of a ship, together with those of her officers.

STORES, if any person who has the charge or custody of any of the king's armour, ordnance, ammunition, shot, powder, or habiliments of war, or of any victuals for victualling the navy, shall, to hinder his majesty's service, embezzle, purloin, or convey away the same to the value of 20s. or shall steal or embezzle any of his majesty's sails, cordage, or any other of his naval stores, to the value of 20s. he shall be adjudged guilty of felony, without benefit of clergy. 22 Car. II. c. 5.

STORK, a large bird of the heron class, of which many particulars are related that are remarkably singular. It is a bird of passage. Egypt is said to be the place of its winter residence. It is in high repute among the Mahometans, approaching almost to veneration.

**STORM**, a term signifying a fall of snow, hail, or rain; also high wind, thunder, &c. In some places the term is restricted to high winds, thunder, &c.

**STOVE**, in Building, is a hot-house or room, but in a more restricted sense it is a place in which fires in dwelling houses are made, and so contrived that it may communicate heat to the room, and send the smoke up the chimney. Stoves are of various constructions, and numerous patents have been taken out for inventions and improvements in what had been previously known. The great excellence of a stove consists in its adaptation to give the heat to the room, and to exclude the smoke. Towards these desirable objects many advances have been made, both by Englishmen and foreigners; but much yet remains to be done. See FIRE-PLACE.

**STOVES**, square boxes made of plank, and lined with brick, for burning charcoal in, to dress the admiral's victuals.

**STOWAGE**, the general disposition of the several materials contained in a ship's hold, with regard to their figure, magnitude, or solidity. In the stowage of different articles, as ballast, casks, cases, bales, or boxes, there are several general rules to be observed, according to the circumstances or qualities of those materials. The casks which contain any liquid are, according to the sea phrase, to be bung up and bilge free, that is, closely wedged up in an horizontal position, and resting on their quarters, so that their bilges (or where they measure most round) being entirely free, cannot rub against each other, or the ship's side, by the motion of the vessel. Dry goods, or such as may be damaged by the water, are to be carefully enclosed in casks, bales, cases, or wrappers, and wedged off from the bottom or sides of the ship, as well as from the bows, masts, and pump-well, &c. Due attention must likewise be had to their disposition, with regard to each other, and to the trim and centre of gravity of the ship, so that the heaviest may always be nearest the keel, and the lightest gradually above them.

**STRAIT**, a narrow channel or arm of the sea, contained between two opposite shores; as, the straits of Gibraltar, the straits of Sunda, the straits of Dover, &c.

**STRAKES**, or STREAKS, the uniform ranges of planks on the bottom or sides of a ship, or the continuation of planks joined to the end of each other, and reaching from the stern, which limits the vessel forward, to the stern-post and fashion-pieces, which terminate her length abaft. *Garboard-Streak*, is the lowest streak or range of planks, being let into rabbets in the keel below, and in the stem and stern-post at the ends. See the article KEEL.

**STRAMONIUM**, in Botany, *Datura*, Common Thornapple, is a powerful narcotic poison, and in many instances its deleterious effects have been attended with pernicious, and even fatal consequences. Some have fancied that smoking stramonium has proved beneficial in asthmatic complaints, and for shortness of breath.

**STRAND**, one of the twists or divisions of which a rope is composed. *Strand* also implies the sea-beach. *Stranded*, speaking of a cable or rope, signifies that one of its strands is broken. *Stranded*, applied to a vessel, means that she has run aground on the sea-shore, either by a tempest, or through bad steerage. Where any vessel is stranded, the justices of the peace are empowered to command the constables near the coast to call assistance, in order to preserve the ship, if possible.

**STRAPADO**, a barbarous military punishment, now abandoned. It consisted in having the hands of the offender tied behind his back, by which he was drawn to a certain elevation by a rope, then left to run suddenly towards the ground, when being stopped with a sudden jerk, his shoulders were dislocated. This was also one of the punishments of the inquisition, and perhaps it has been re-established with the restoration of that infernal tribunal.

**STRATA**, in Natural History, the several beds or layers of different matters, whereof the body of the earth is composed.

**STRATAGEM**, in War, a military wile or device for deceiving or deluding an enemy. The ancients were more expert in stratagems than the moderns, except the Indians of America, who in this art of circumvention are exceedingly dexterous.

**STRAW**, in Agriculture, the common name of the stem on which grain grew, and from which it is thrashed. A considerable portion is used as fodder, for various other purposes, and finally as manure.

**STREAKY CHEESE**, in rural economy, is made from a mixture of new and old curd, or of two sorts which have different proportions of colouring in them, giving a variegated appearance, and hence the name.

**STREAM TIN**, in Mineralogy, consists of particles or masses of tin ore, found beneath the surface in alluvial grounds, generally in low situations. Its name is derived from the streams of water used to separate the earthy matter from it. This ore is of the best quality, and is occasionally mixed with small particles of gold. *Stream Works*, are the usual repositories in which the stream tin is found. *Streaming*, denotes the management of a stream work, or of stream tin during the process of refinement.

**STRENGTH.** All experiments made on the strength of materials, when well conducted, are highly valuable, in as much as they lie at the very foundation of mechanical science, as applied to practice. Those acquainted with the history of mechanics, cannot be ignorant that many machines, otherwise well contrived, have been found quite inadequate to their proposed ends; some of them not having strength enough, in different parts, to bear the pressure of the rest; and others, on the contrary, so loaded with unnecessary matter as to be ready to fall to pieces by their own weight. The same remark is applicable to architectural structures, many of which have given way only from a want of due proportion in the strength and weight of the different parts. And we add, that the value of such experiments is greatly increased, by having the manner in which they were conducted, (as in the present instance,) laid before the public; as any error in applying the means employed, or in deducing the inferences, is thus avoided; or, if any have been committed, may be detected. We purpose, therefore, in the first place in this article, to lay before our readers some experiments made by George Rennie, Esq. civil engineer, and which were first published in the Philosophical Transactions for 1818. The notes with which the article is accompanied, add not a little to its value, being by Mr. Thomas Tredgold, to whom the public is indebted for several valuable practical works, possessing considerable merit, and highly useful to mechanics and builders. The notes were first given to the world in the late Dr. Tilloch's Magazine for 1819.

*Preliminary Remarks.*—The knowledge of the properties of bodies which come more immediately under our observation, is so instrumental to the progress of science, that any approximation to it deserves our serious attention. The passage over a deep and rapid river, the construction of a great and noble edifice, or the combination of a more complicated piece of mechanism, are arts so peculiarly subservient to the application of these principles, that we cannot be said to proceed with safety and certainty, until we have assigned their just limits. The vague results on which the more refined calculations of many of the most eminent writers are founded, have given rise to such a multiplicity of contradictory conclusions, that it is difficult to choose, or distinguish the real from that which is merely specious. The connexions are frequently so distant, that little reliance can be placed on them. The Royal Society appears to have instituted, at an early period, some experiments on this subject, but they have recorded little to aid us. Emerson, in his Mechanics, has laid down a number of rules and approximations. Professor Robinson, in his excellent treatise in the Encyclopædia Britannica; Banks on the Power of Machines; Dr. Anderson, of Glasgow; Colonel Beaufoy, &c. are those, amongst our countrymen, who have given the result of their experiments on wood and iron. The subject, however, appears to have excited considerable attention on the continent. A theory was published in the year 1638, by Galileo, on the resistance of solids, and subsequently by many other philosophers. But however plausible these investigations appeared, they were more theoretical than practical, as will be seen in the sequel. It is only by deriving a theory from careful and well-directed experiments, that practical results can be obtained. It would be useless to enumerate the labours of those philosophers, who in following, or varying from, the steps of Galileo, have merely tended to obscure a subject, respecting which they had no data to proceed upon. It is sufficient to enumerate the names of those who, in conjunction with our own countrymen, have added their labours to the little knowledge we possess. The experiments of Buffon, recorded in the Annals of the Academy of Sciences at Paris, in the years 1740 and 1741, were on a scale sufficiently large to justify every conclusion, had he not omitted to ascertain the direct and absolute strength of the timber employed. It, however, appeared from his experiments, that the strength of the ligneous fibre is nearly in proportion to the specific gravity. Muschenbroeck, whose accuracy (it is said) entitled him to confidence, made a number of experiments on wood and iron, which, by being tried on various specimens of the same materials, afforded a mean result considerably higher than any other previous authorities. Experiments have also been made by Mariotte, Varignon, Perronet, Ramus, Rondelet, Gauthey, Navier, Aubry, and Texier de Norbeck, as also at the *Ecole Polytechnique*, under the direction of M. Prony. With such authorities before us, it might be deemed presumption in me, to offer a communication on a subject which had been previously treated of by so many able men.[*] But whoever has had occasion to investigate the principles upon which any edifice is constructed, where the combination of its parts is more the result of uncertain rules than sound principle, will soon find how scanty is our knowledge on a subject so highly important. The desire of obtaining some approximation, which could only be accomplished by repeated trials on the substances themselves, induced me to undertake the following experiments.

*Description of the Apparatus.* (See the Plate.)—A bar of the best English iron, about ten feet long, was selected, and formed into a lever (whose fulcrum is denoted by *f*). The hole was accurately bored, and the pin turned, which suffered it to move freely. The standard A was firmly secured by the nut *c* to a strong bed-plate of cast iron, made firm to the ground. The lever was accurately divided in its lower edge, which was made straight in a line with the fulcrum. A point, or division, D, was selected, at five inches from the fulcrum, at which place was let in a piece of hardened steel. The lever was balanced by the balance weight E, and in this state it was ready for operation. But in order to keep it as level as possible, a hole was drilled through a projection on the bed-plate, large enough to admit a stout bolt easily through it, which again was prevented from turning in the hole by means of a tongue *t*, fitting into a corresponding groove in the hole. So that, in order to preserve the level, we had only to move the nut to elevate or depress the bolt, according to the size of the specimen. But as an inequality of pressure would still arise from the nature of the apparatus, the body to be examined was placed between two pieces of steel, the pressure being communicated through the medium of two pieces of thick leather above and below the steel pieces, by which means a more equal contact of surfaces was attained.[†] The scale was hung on a loop of iron, touching the lever in an edge only. I at first used a rope for the balance-weight, which indicated a friction of four pounds, but a chain diminished the friction one half. Every moveable centre was well oiled. Of the resistances opposed to the simple strains which may disturb the quiescent state of a body, the principal are the repulsive force, whereby it resists compression, and the force of cohesion, whereby it resists extension. On the former, with the exception of the experiments of Gauthey and Rondelet on stones, and a few others on soft substances, there is scarcely any thing on record. In the memoir of M. Lagrange, on the force of springs, published in the year 1760, the moment of elasticity is represented by a constant quantity, without indicating the relation of this value to the size of the spring: but in the memoir of the year 1770, on the forms of columns, where he considers a body whose dimensions and thickness are variable, he makes the moment of elasticity proportional to the fourth power of the radius, in observing the relations of theory and practice to accord with each other. This was admitted by Euler in his memoir of 1780, in his elaborate investigation of the forms of columns. Mr. Coulomb had, however, shewn before that time, how inapplicable all these calculations were to columns under common circumstances; and similar observations have been made in subsequent lectures on natural philosophy. The results of experiments have also been equally discordant; since it is deduced from those of Reynolds, that the power required to crush a cubic quarter of an inch of cast iron is 448000 lbs. avoirdupois, or 200 tons; whereas by the average of thirteen experiments made by me on cubes of the same size, the amount never exceeded 10392·53 lbs. not quite five tons.[‡] This may be seen by referring to the tables. There were four kinds of iron used, *viz.* 1st. Iron taken from the centre of a large block, whose crystals were similar in appearance and magnitude to those evinced in the fracture of what is usually termed gun-metal. 2dly. Iron taken from a small casting, close-grained, and of a dull gray colour. 3dly. Iron cast horizontally in bars of $\frac{3}{8}$ inches square, 8 inches long. 4thly. Iron cast vertically, same size as last. These castings were reduced equally on every side to $\frac{1}{4}$ of an inch square: thus removing the hard external coat usually surrounding metal castings. They were all subjected to a gauge. The bars were then presumed to be tolerably uniform. The weights used were of the best kind that could be procured, and as the experiment advanced, smaller weights were used.

*Experiments on Cast-Iron in Cubes of $\frac{1}{8}$ of an Inch, &c.*—Iron taken from the block whose specific gravity was 7·033.

| Averages. | | lbs. avoirdupois. |
|---|---|---|
| 1439·66 | $\frac{1}{8}\times\frac{1}{8}$ | 1454 |
| | $\frac{1}{8}\times\frac{1}{8}$ | 1416 |
| | $\frac{1}{8}\times\frac{1}{8}$ | 1449 |

On specimens of different lengths. Specific gravity of iron 6·977.

| | | | |
|---|---|---|---|
| 2116 | $\frac{1}{8}\times\frac{2}{8}$ | | 1922 |
| | $\frac{1}{8}\times\frac{2}{8}$ | | 2310 |
| 1758·5 | $\frac{1}{8}\times\frac{3}{8}$ | slipped with 1863 lbs. filed flat, and crushed with | 2363 |
| | $\frac{1}{8}\times\frac{4}{8}$ | ditto, ...... 1495, ditto | 2005 |
| | $\frac{1}{8}\times\frac{5}{8}$ | ditto, | 1407 |
| | $\frac{1}{8}\times\frac{6}{8}$ | ditto, | 1743 |
| | $\frac{1}{8}\times\frac{7}{8}$ | ditto, | 1594 |
| | $\frac{1}{8}\times\frac{8}{8}$ | ditto, | 1439 |

*April* 23, 1817. *Experiments on Cubes of $\frac{1}{4}$ of an Inch, taken from the Block.*

| | | |
|---|---|---|
| 9773·5 | $\frac{1}{4}\times\frac{1}{4}$ | 10561 |
| | $\frac{1}{4}\times\frac{1}{4}$ | 9596 |
| | $\frac{1}{4}\times\frac{1}{4}$ | 9917 |
| | $\frac{1}{4}\times\frac{1}{4}$ | 9020 |

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[*] It is true that the subject has been considered by many able philosophers, from Galileo down to the present period; but it is only lately that the proper object of attention has been ascertained; or at least the results of their inquiries had not been brought forward in a practicable form. For when Dr. T. Young published his Lectures, there was little on the subject besides the intricate, and I may add unsatisfactory, investigations of Euler and Lagrange. As to the resistance to fracture, which with the greater part of mechanical writers is the only object attended to, it is of very inferior importance.—The laws of flexure constitute the chief guide in the construction of buildings: and the intention of these notes is to call the attention of experimentalists to this part of the subject: and as it is probable the ingenious author of the experiments now before me may be tempted to resume his labours, I feel certain that he will not feel displeased to have his attention called to some interesting points of inquiry, which he has either omitted to notice, or has not given to the public.—T. T.

[†] This machine must have had a considerable degree of friction, and Mr. Rennie has not, apparently, attempted to determine the quantity: it must however have been very great in the high pressures. The lever turned upon a pin similar to that used by Gauthey, (Rozier's *Journal de Physique*, tome iv. p. 403,) which Perronet found to have much friction, and to cause great irregularity. To remedy the defects of this machine, another was contrived by Rondelet, in which he attempted, and it appears successfully, to obviate the most material defects of the old one. The action was more equal on the compressed surface, and a more accurate measure of the strength was obtained. Rondelet's machine is described in his *Traité Theorique et Practique de l'Art de Bâtir*, tome iii. p. 79.—T. T.

[‡] It is probable that Mr. Reynolds made his experiments on metal cast at the furnace of Maidley Wood, which is of a very strong and superior quality; but this circumstance can have been but of little importance compared to the great disproportion of the results.—T. T.

RENNIE'S EXPERIMENTS on the STRENGTH of MATERIALS

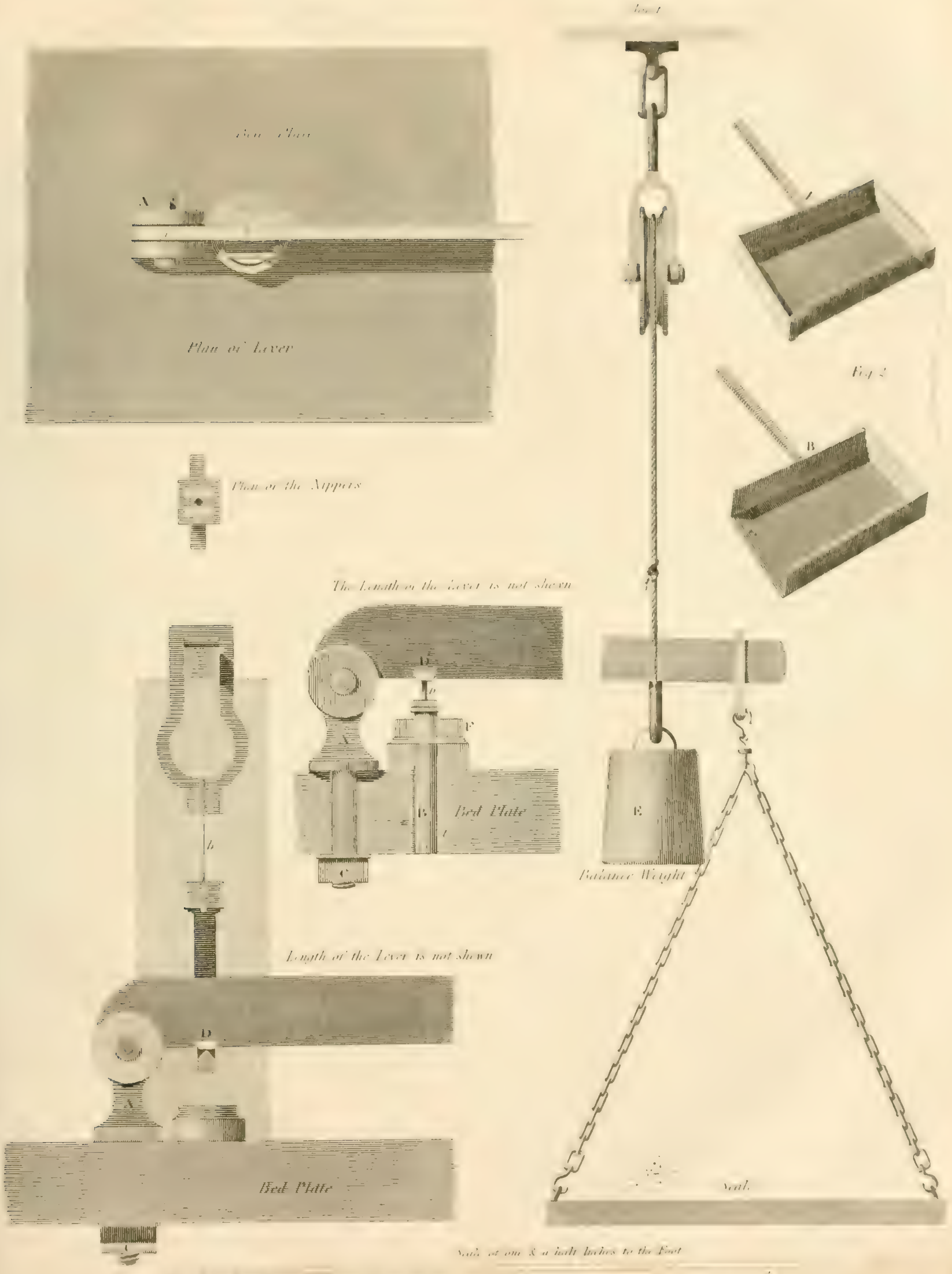

Fig. 1
Bed Plate
A
B
Plan of Lever
Plan of the Nippers
The Length of the Lever is not shewn
D
b
F
A
B
Bed Plate
C
b
Length of the Lever is not shewn
D
A
Bed Plate
C
Fig. 2
A
B
E
Balance Weight
Scale
Scale of one & a half Inches to the Foot

### *Castings, Horizontal. Specific Gravity 7·113.*

| | | | lbs. avoirdupois. |
|---|---|---|---|
| 10114 | ¼ × ¼ | | 10432 |
| | ¼ × ¼ | | 10720 |
| | ¼ × ¼ | | 10605 |
| | ¼ × ¼ | | 8699 |

### *Vertical Castings. Specific Gravity 7·074.*

| | | | |
|---|---|---|---|
| 11136 75 | ¼ × ¼ | bottom of vertical bar | 12665 |
| | ¼ × ¼ | | 10950 |
| | ¼ × ¼ | | 11088 |
| | ¼ × ¼ | | 9844 |
| | ¼ × ¼ | full size. Scale broke with 10294; tried again | 11006 |

A prism, having a logarithmic curve for its limits, resembling a column; it was ¼ of an inch diameter by one inch long, broke with ........ 6954

### *April 28th. Trials on Prisms of different Lengths.*

| | | | |
|---|---|---|---|
| 9414 5 | ¼ × ½ | horizontal | 9455 |
| | ¼ × ½ | ditto | 9374 |
| | ¼ × ½ | ditto, bad trial, 9006 lbs. | |
| 9982 5 | ¼ × ½ | vertical | 9938 |
| | ¼ × ½ | ditto | 10027 |

### *April 29th. Horizontal Castings.*

| | | |
|---|---|---|
| ¼ × ⅜ | | 9006 |
| ¼ × ⅝ | | 8845 |
| ¼ × 6/8 | | 8362 |
| ¼ × ⅞ | | 6430 |
| ¼ × 8/8 | or one inch long | 6321 |

### *Vertical Castings.*

| | | |
|---|---|---|
| ¼ × ⅜ | | 9328 |
| ¼ × ⅝ | | 8585 |
| ¼ × 6/8 | a small defect in the specimen | 7896 |
| ¼ × ⅞ | | 7018 |
| ¼ × 8/8 | or one inch | [*]6430 |

### *Experiments on different Metals.*

| | | | | |
|---|---|---|---|---|
| ¼ × ¼ | cast copper, crumbled with | | | 7318 |
| ¼ × ¼ | fine yellow brass reduced | $\frac{1}{10}$ with 3213· | ½ with.... | 10304 |
| ¼ × ¼ | wrought copper, | $\frac{1}{16}$ .... 3427· | ⅛ ........ | 6440 |
| ¼ × ¼ | cast tin, | $\frac{1}{16}$ .... 552· | ⅛ ........ | 966 |
| ¼ × ¼ | cast lead, | | ½ ........ | [†]483 |

The anomaly between the three first experiments on ⅛ cubes, and the two second of a different length, can only be accounted for, on the difficulty of reducing such small specimens to an equality. The experiments on ⅛ inch prisms of different lengths give no ratio. The experiments on ¼ inch cubes, taking an average of the three first in each, give a proportion between them and the three on ⅛ cubes,

as 1 : 6·096 in the block castings
as 1 : 7·352 in the horizontal ditto,
as 1 : 8·035 in the vertical ditto,

in several cases the proportion is as the cubes.—The vertical cube castings are stronger than the horizontal cube castings.—The prisms usually assumed a curve similar to a curve of the third order, previous to breaking. The experiments on the different metals give no satisfactory results. The difficulty consists in assigning a value to the different degrees of diminution. When compressed beyond a certain thickness, the resistance becomes enormous.

*Experiments on the Suspension of Bars.*—The lever was used as in the former case, but the metals were held by nippers, as indicated in the drawing No. 2. They were made of wrought iron, and their ends adapted to receive the bars, which, by being tapered at both extremities, and increasing in diameter from the actual section, (if I may so express it,) and the jaws of the nippers being confined by a hoop, confined both. The bars, which were six inches long, and ¼ square, were thus fairly an firmly grasped.

April 30, 1817

| No. | | | | lbs. |
|---|---|---|---|---|
| 45 | ¼ | inch, cast-iron bar, horizontal | 1166 | 1193 5 |
| 46 | ¼ | do. do. vertical | 1218 | |
| 47 | ¼ | do. cast steel previously tilted | 8391 | |
| 48 | ¼ | do. blister steel, reduced per hammer | 8322 | |
| 49 | ¼ | do. shear steel, do. do. | 7977 | |
| 50 | ¼ | do. Swedish iron, do. do. | 4504 | |
| 51 | ¼ | do. English iron, do. do. | 3492 | |
| 52 | ¼ | do. hard gun-metal, mean of two trials | 2273 | |
| 53 | ¼ | do. wrought copper reduced per hammer | 2112 | |
| 54 | ¼ | do. cast copper | 1192 | |
| 55 | ¼ | do. fine yellow brass | 1123 | |
| 56 | ¼ | do. cast tin | 296 | |
| 57 | ¼ | do. cast lead | 114 | |

*Remarks on the last Experiments.*—The ratio of the repulsion of the horizontal cast cubes to the cohesion of horizontal cast bars, is 8·65 : 1. The ratio of the vertical cast cubes to the cohesion of the vertical cast bars, is as 9·14 : 1. The average of the bars, compared with the cube, No. 16, is as 10 611 : 1. The other metals decrease in strength, from cast steel to cast lead.

The stretching of all the wrought bars indicated heat.[*] The fracture of the cast bars was attended with very little diminution of section, scarcely sensible.

The experiment made by M. Prony, (which asserts, that, by making a slight incision with the file, the resistance is diminished one half,) was tried on a ¼ inch bar of English iron; the result was 2920 lbs., not a sixth part less. This single experiment, however, does not sufficiently disprove the authority of that able philosopher, for an incision is but a vague term. The incision I made might be about the 40th part of an inch.

*Experiments on the Twist of ¼ Inch Bars.*—To effect the operation of twisting off a bar, another apparatus was prepared: it consisted of a wrought-iron lever two feet long, having an arched head about 1-6th of a circle, of four feet diameter, of which the lever represented the radius, the centre round which it moved had a square hole made to receive the end of the bar to be twisted. The lever was balanced as before, and a scale hung on the arched head; the other end of the bar being fixed in a square hole in a piece of iron, and that again in a vice. The undermentioned weights represent the quantity of weight put into the scale.

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[*] In these experiments, the results are so irregular, that no practical conclusions can be derived from them. There are many circumstances that affect the results of such experiments, which were observed by Gauthey; such as the position of the specimen, the form of its surfaces, and the inequality of the different specimens—which were so extremely small, that it would be scarcely possible to obtain any tolerable degree of accuracy.

Gauthey's experiments exhibit a like irregularity, indicating no relation between the height of the piece and its resistance, (Rozier's *Journal*, tome iv. p. 107.) It appears probable that when the fracture is of that kind where the body decomposes into pyramids, the length does not influence the result, provided that the piece be long enough to admit of the free motion of the fractured parts. I imagine that hard cast iron breaks into pyramids, but the nature of the fracture Mr Rennie has not stated. Probably it was so soft as to break in the manner of flexible bodies, in which, though the forces must act according to some regular law, it is difficult to trace their operation in a continuous solid.—T. T.

[†] The degree of compression of these bodies having been observed, we might conclude that the height of the modulus of elasticity might be obtained from these experiments. This, however, is not the case; and so far proves that the strain is not of that simple kind which it has been supposed to be. The reduction of length might be easily measured, even in hard bodies, by an apparatus for multiplying its extent; and it would throw much light on the subject, to reduce pieces of the same length but of different areas to a given length. Such a set of experiments would be infinitely more valuable than those on the fracture, and much more easily made, as the apparatus would be easier to manage.

The importance of the laws of stiffness over those of strength has been ably stated by Dr. Young, (Lectures on Natural Philosophy, vol. 1.) and what he has stated in favour of stiffness applies equally to the mode of experimenting I now recommend, which could not fail of establishing some important practical rules.—T. T.

[‡] Mr. Rennie's apparatus did not permit of measuring the extension of the specimens. In some experiments made by Mr. Telford, (Barlow's Essay on the Strength of Timber, &c. p. 230,) where the extension was measured, it appears to have been greatest at the middle of the length, and to increase from the ends towards the middle in a ratio sensibly proportional to the square of the distance from the end. This fact is at variance with the received opinion respecting the strain.

Dr. Thomson has remarked, (Annals of Philosophy, vol. xii. p. 450,) that the strengths of English and Swedish iron are not in the same proportion as is found by comparing Count Sickengen's with that described in the Annals for April 1816. But if I do not mistake, Sickengen's was made on wire, and consequently would be higher, as the strength is always much increased by forging, wire-drawing, &c.—T. T.

May 30, 1817.

### *On Twists close to the bearing, cast horizontal.*

| No. | | lbs. | oz. | |
|---|---|---|---|---|
| 58 | ¼ in bars, twisted as under with | 10 | 14 | in the scale. |
| 59 | ½ do. bad casting | 8 | 4 | |
| 60 | ¼ do. | 10 | 11 | |
| | Average | 9 | 15 | |

### *Cast vertical.*

| No. | | lbs. | oz. | | |
|---|---|---|---|---|---|
| 61 | ¼ | 10 | 8 | | |
| 62 | ¼ | 10 | 13 | | |
| 63 | ¼ | 10 | 11 | | |
| | | | | 10 | 10 |

### *On different Metals.*

| No. | | lbs. | oz. |
|---|---|---|---|
| 64 | Cast steel | 17 | 9 |
| 65 | Shear steel | 17 | 1 |
| 66 | Blister steel | 16 | 11 |
| 67 | English iron, wrought | 10 | 2 |
| 68 | Swedish iron, wrought | 9 | 8 |
| 69 | Hard gun-metal | 5 | 0 |
| 70 | Fine yellow brass | 4 | 11 |
| 71 | Copper, cast | 4 | 5 |
| 72 | Tin | 1 | 7 |
| 73 | Lead | 1 | 0 |

### *On Twists of different Lengths.*

| Horizontal. | | | | Vertical. | | | |
|---|---|---|---|---|---|---|---|
| No. | | Weight in Scale. | | No. | | Weight in Scale. | |
| 74 | ¼ by ½ long | 7 | 3 | 77 | ¼ by ½ do. | 10 | 1 |
| 75 | ¼ by ¾ do. | 8 | 1 | 78 | ¼ by ¾ do. | 5 | 9 |
| 76 | ¼ by 1 inch do. | 8 | 8 | 79 | ¼ by 1 inch do. | 8 | 5 |

### Horizontal Twists at 6 from the bearing.

| No. | | lbs. | oz. |
|---|---|---|---|
| 80 | ¼ by 6 inches long | 10 | 9 |
| 81 | ¼ by do. do. | 9 | 4 |
| 82 | ¼ by do. do. | 9 | 7 |

### Twists of ½ inch square bars, cast horizontally.

| No. | | qrs. | lbs. | oz. | |
|---|---|---|---|---|---|
| 83 | ½ close to the bearing | 3 | 9 | 12 | end of the bar hard. |
| 84 | ½ do. | 2 | 18 | 0 | middle of the bar. |
| 85 | ½ at 10 inches from bearing, lever in the middle | 1 | 24 | 0[*] | |

### *On Twists of different Materials.*

These experiments were made close to the bearing, and the weights were accumulated in the scale until the substances were wrenched asunder.

| No | | Weight of Scale. | | No. | | Weight of Scale. | |
|---|---|---|---|---|---|---|---|
| 86 | Cast steel | 19 | 9 | 91 | Hard gun-metal | 5 | 0 |
| 87 | Shear steel | 17 | 1 | 92 | Fine yellow brass | 4 | 11 |
| 88 | Blister steel | 16 | 11 | 93 | Copper | 4 | 5 |
| 80 | English iron, No. 1. | 10 | 2 | 94 | Tin | 1 | 7 |
| 90 | Swedish iron | 9 | 8 | 95 | Lead | [†]1 | 0 |

*Remarks.*—Here the strength of the vertical bars still predominates. The average of the two taken conjointly, and compared with a similar case of ½ inch bars, gives the ratio as the cubes, as was anticipated. In the horizontal castings of different lengths, the balance is in favour of the increased lengths; but in the vertical castings, it is the reverse. In neither is there any apparent ratio. In the horizontal castings at 6 inches from the bearing, there is a visible increase, but not so great as when close to the bearing.

### *June* 4, 1817. *Miscellaneous Experiments on the Crush of One Cubic Inch.*

| No. | | lbs. avoidupois. |
|---|---|---|
| 96 | Elm | 1842 |
| 97 | American pine | 1606 |
| 98 | White deal | 1928 |
| 99 | English oak, mean of two trials | 3860 |
| 100 | Ditto, of 5 inches long, slipped with | 2572 |
| 101 | Ditto, of 4 inches ditto | 5147[‡] |
| 102 | A prism of Portland stone 2 inches long | 805 |
| 103 | Ditto, statuary marble | 3216 |
| 104 | Craig Leith | 8683 |

In the following experiments on stones, the pressure was communicated through a kind of pyramid, the base of which rested on the hide leather, and that on the stone.[§] The lever pressed upon the apex of the pyramid. Cubes of one and a half inch.

| No. | | Spec. grav. | lbs. avoir. |
|---|---|---|---|
| 105 | Chalk | | 1127 |
| 106 | Brick of a pale red colour | 2·085 | 1265 |
| 107 | Roe-stone, Gloucestershire | | 1449 |
| 108 | Red brick, mean of two trials | 2·168 | 1817 |
| 109 | Yellow face-baked Hammersmith paviors 3 times | | 2254 |
| 110 | Burnt do. mean of two trials | | 3243 |
| 111 | Stourbridge or fire brick | | 3864 |
| 112 | Derby grit, a red friable sand-stone | 2·316 | 7070 |
| 113 | Ditto, from another quarry | 2·428 | 9776 |
| 114 | Killaly white freestone, not stratified | 2·423 | 10264 |
| 115 | Portland | 2·428 | 10284 |
| 116 | Craig Leith, white freestone | 2·452 | 12346 |

### *June 5th, 6th, and 7th,* 1817.

| No. | | Spec. grav. | lbs. avoir. |
|---|---|---|---|
| 117 | Yorkshire paving with the strata | 2·507 | 12856 |
| 118 | Ditto do. against the strata | 2·507 | 12856[‖] |
| 119 | White statuary marble not veined | 2·760 | 13632 |
| 120 | Bramley Fall sandstone, near Leeds, with strata | 2·505 | 13632 |
| 121 | Ditto, against the strata | 2·506 | 13632 |
| 122 | Cornish granite | 2·662 | 14302 |
| 123 | Dundee sandstone or brescia, two kinds | 2·530 | 14918 |
| 124 | A two-inch cube of Portland | 2·423 | 14918 |
| 125 | Craig Leith with the strata | 2·452 | 15560 |
| 126 | Devonshire red marble, variegated | | 16712 |
| 127 | Compact limestone | 2·584 | 17354 |
| 128 | Peterhead granite hard close grained | | 18636 |
| 129 | Black compact limestone, Limerick | 2·598 | 19924 |
| 130 | Purbeck | 2·599 | 20610 |
| 131 | Black Barbant marble | 2·697 | 20742 |
| 132 | Very hard freestone | 2·528 | 21254 |
| 133 | White Italian veined marble | 2·726 | 21783 |
| 134 | Aberdeen granite, blue kind | 2·625 | 24556[¶] |

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[*] In the resistance to twisting, there are some doubts by different writers expressed respecting the effect of the length: these experiments, however, do not appear calculated to remove them; they are so extremely irregular. The angle of torsion was not observed, though it certainly would not have been difficult to have done so in the longer pieces. Some experiments on larger specimens are described in Thomson's Annals for March 1819; but we cannot compare them with these, for want of a more correct knowledge of the nature of this strain.—T. T.

[†] These experiments are merely a repetition of those in a preceding page, experiments 61 to 73; except that here cast steel is stated to be 19 lbs. 9oz. instead of 17lbs. 9oz.

[‡] The experiments on wood are considerably below those of other writers; and it appears singular that the four-inch specimen should be stronger than the shorter length. According to Rondelet's experiments to crush a cubic inch of oak it required from 5000 to 6000lbs. avoirdupois.
of fir - from 6000 to 7000lbs.
In the former the pieces were compressed 1-3d of their length; in the latter, one half of their length (Rondelet's *L'Art de Bâtir*, tome iv. p. 67.) Mr. Rennie has not stated the diminution of length.—T. T.

[§] It certainly would have been preferable to have placed a hard and rigid substance next the stone, in order to secure equality of pressure.—T. T.

[‖] Gauthey tried the stones in different positions in respect to their natural beds; but from a general view of his experiments, it does not appear that he was correct in concluding them to be stronger when "*posées en delit*," because his comparison is made between means that include sections of very different forms. (Rozier's *Journ.* tome iv. p. 406.)—T. T.

[¶] According to Gauthey's experiments, a cubic inch

of brick, specific gravity 1·557, was crushed by 1562 lbs. avoirdupois.
of Flanders marble .... 2·628 .............. 13142
of Genoese do......... 2·700 .............. 4856
of porphyry .......... 2·871 .............. 35568—T. T

N. B. The specific gravities were taken with a delicate balance, made by Creighton of Glasgow; all with the exception of two specimens, which were by accident omitted.[*]

*Remarks.*—In observing the results presented by the preceding table, it will be seen that little dependence can be placed on the specific gravities of stones, so far as regards their repulsive powers, although the increase is certainly in favour of their specific gravities. But there would appear to be some undefined law in the connexion of bodies, with which the specific gravity has little to do. Thus, statuary marble has a specific gravity above Aberdeen granite, yet a repulsive power not much above half the latter. Again, hardness is not altogether a characteristic of strength, inasmuch as the limestones, which yield readily to the scratch, have nevertheless a repulsive power approaching to granite itself.[†]

It is a curious fact in the rupture of amorphous stones, that pyramids are formed, having for their base the upper side of the cube next the lever, the action of which displaces the sides of the cubes, precisely as if a wedge had operated between them. I have preserved a number of the specimens, the sides of which, if continued, might cut the cubes in the direction of their diagonals.

*Experiments made on the transverse Strain of cast Bars, the Ends loose. June 8th, 1817.*[‡]

| No. | | Weight of bars. lbs. | oz. | dist. of bearings. ft. | | lbs. avoir. |
|---|---|---|---|---|---|---|
| 135 | Bar of 1 inch square ............ | 10 | 6 | 3 | 0 | 897 |
| 136 | Do. of 1 inch do. .............. | 9 | 8 | 2 | 8 | 1086 |
| 137 | Half the above bar ............ | | | 8 | 1 | 2320 |
| 138 | Bar of 1 inch square, through the diagonal .................. | 2 | 8 | 2 | 8 | 851 |
| 139 | Half the above bar ............ | | | 1 | 4 | 1567 |
| 140 | Bar of 2 inches deep, by ½ inch thick .................... | 9 | 5 | 2 | 8 | 2185 |
| 141 | Half the above bar ............ | | | 1 | 4 | 4508 |
| 142 | Bar 3 in. deep, by ⅓ inch thick .. | 9 | 15 | 2 | 8 | 3588 |
| 143 | Half the bar .................. | | | 1 | 4 | 6854 |
| 144 | Bar 4 inches, by ¼ inch thick.... | 9 | 7 | 2 | 8 | 3979 |
| 145 | Equilateral triangles with the angle up and down. | | | | | |
| 146 | Edge or angle up .............. | 9 | 11 | 2 | 8 | 1437 |
| 147 | ——— angle down............ | 9 | 7 | 2 | 8 | 840 |
| 148 | Half the first bar .............. | | | 1 | 4 | 3059 |
| 149 | Half the second bar............ | | | 1 | 4 | 1656 |
| 150 | A feather-edged or ⊥ bar, whose dimensions were | | | | | |
| 151 | 2 inches deep by 2 wide | 10 | 0 | edge up 2 | 8 | 3105 |
| 152 | Half of ditto. | | | | | |

N. B. All these bars contained the same area, though differently distributed as to their forms.

*Experiments made on the Bar of 4 Inches deep by ¼ Inch thick, by giving it different Forms, the Bearings at 2 Feet 8 Inches, as before.*

| No. | | lbs. | lbs. |
|---|---|---|---|
| 153 | Bar formed into a semi ellipse, weighed | 7 | 4060 |
| 154 | Ditto, parabolic on its lower edge | .. | 3860 |
| | Ditto, of 4 inches deep by ¼ inch thick | ,, | 3979 |

*Experiments on the transverse Strain of Bars, one end made fast, Weight being suspended at the other, at 2 feet 8 inches from the the Bearing.*

| No. | | | lbs. |
|---|---|---|---|
| 155 | An inch square bar bore ..................... | .. | 280 |
| 156 | A bar 2 inches deep, by ½ an inch thick ...... | ,, | 539 |
| 157 | An inch bar, the ends made fast............. | ,, | 1173 |

The paradoxical experiment of Emerson was tried which states that by cutting off a portion of an equilateral triangle, (see page 114 of Emerson's Mechanics,) the bar is stronger than before, that is, a part stronger than the whole! The ends were loose at 2 feet 8 inches apart as before. The edge from which the part was intercepted was lowermost, the weight was applied on the base above, it broke with 1129 lbs. whereas in the other case it bore only 840 lbs.

*Remarks on the Transverse Strain* Banks makes his bar from the cupola, when placed on bearings 3 feet asunder, and the ends loose, to bear .......................... 864 lbs.

Now, all my bars were cast from the cupola, the difference was therefore ................................ 33 lbs.

I adopted a space of 2 feet 8 inches asunder, as being more convenient for my apparatus. The strength of the different bars, all cases being the same, approaches nearly to the theory which makes the comparative values as the breadths multiplied into the squares of the depths. The halves of the bars were tried merely to keep up the analogy. The bar of 4 inches deep, however, falls short of theory by 365 lbs. It is evident we can not extend the system of deepening the bar much further, nor does the theory exactly maintain in the case of the equilateral triangle by ................................. 243 lbs.

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[*] Mr. Rennie has, of course, taken the specific gravity in the usual manner, but certainly not the real specific gravity of the stone in any of the porous ones, though it may be that of the material the stone is composed of. When a stone is porous—and many building stones are very much so—it will be found that the specific gravity, as usually obtained, is not the weight of a cubic foot in ounces avoirdupois, which it certainly ought to be, and particularly where the information is intended for the use of practical men. If Mr. Rennie were to try any of his specimens, he would find the weight of a cubic foot much below the numbers he has given in the case of brick, oolite, and sandstones. The specific gravity of a minute concretion of Portland stone may be 2·132, or, as Kirwan has it, 2·461, but that of the stone itself is much lower.

Were the real specific gravity of porous stones taken, their comparative heaviness would become a more decisive mineral character than it is according to the present method, and the correction presents no difficulty.—T. T.

[†] A curious circumstance was observed by Rondelet in his experiments; *viz.* that the blocks from the middle of a stratum of stone were of a higher specific gravity than those taken either from the upper or lower part of the stratum. The stones were from Chatillon, Bagneux, &c. He also observed, that in the same kind of stone the strength was as the cube of the specific gravity. (*L'Art de Bâtir*, tome iii. p. 83, *et suiv.*) That any relation should exist between the specific gravity and strength of stones of different kinds was not to be expected, as strength depends on other properties.—T. T.

[‡] It is in these experiments that we have most to regret the want of observations, and those of a nature that would have added little to the labour which all, who make such experiments, must undergo. It is, however, a labour that is, to a mind engaged in the search of knowledge, more pleasing than those unaccustomed to such feelings, can conceive. But too often it is a pleasure that cannot be pursued, except at an expense and encroachment on the hours of business which a professional man can ill afford to indulge in. The defect of these experiments consists in the want of observations on the flexure produced by given weights, particularly in the first degrees of deflexion; and it is the more to be regretted, because we have very few experiments on cast-iron, where such observations have been made. Banks states, that his specimens bent about an inch at the time of fracture; and Dr. Young has calculated the height of the modulus of elasticity from this statement, (Nat. Phil. vol. ii. art. 326,) but it is well known, that the deflexion is not regular when the piece is nearly broken. In Banks's experiments on curved bars, the deflexion is given, but the thickness of the bars is not stated. It is true, Rondelet has made some experiments on cast-iron, where the successive deflexions were registered, but these experiments are not very regular; besides, it would be desirable to have experiments on British iron.

As I have two experiments by me, I shall take this opportunity of laying them before my readers. A bar of cast-iron, from a Welsh foundry, which did not yield easily to the file, was laid upon supports exactly three feet apart; the bar was an inch square, and when 308 lbs. were put into a scale suspended from the middle of its length, the deflexion was found to be 3-16ths of an inch; whence the height of the modulus of elasticity is 6,386,688 feet. The experiment was made by Mr. R. Ebbels, at Garnons, near Hereford. A joist of cast-iron 9 inches deep, resembling in form the letter I, was laid upon supports 19 feet apart, first on its edge, when the deflexion from its own weight was 3-10ths of an inch. It was then laid flatwise, and the deflexion from its own weight was 3½ inches. The castings were from Messrs. Dowson's foundry, Edgeware Road. The iron yielded easily to the file. The height of the modulus of elasticity, according to the experiment on the joint flatwise, is ........ 5,100,000 feet.

—— on the edge is...... 5,700,000 —

The deflexion being very small when the joist was on its edge, perhaps it was not measured with the necessary degrees of accuracy, as a very small error would cause the difference in the result. The following table contains the value of the modulus for cast-iron, according to the experiments above stated.

| | *Height of Modulus in feet.* | *Experimentalists.* |
|---|---|---|
| Cast-iron (Welsh).......... | 6,386,688 | Ebbels. |
| Cast-iron .................. | 3,500,000 | Banks. |
| Cast-iron, gray French ...... | 5,095,480 | Rondelet.[*] |
| Cast-iron, soft do. ........ | 4,217,000 | Rondelet.[*] |
| Cast-iron.................... | 5,700,000 | By my trial.—T.T |

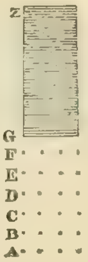
[*] *L'Art de Bâtir*, tome iv. part ii. p. 514.

The diagonal position of the square bar is actually worse than when laid on its side, contrary to many assertions.[*] The same quantity of metal in the feather-edged bars was not so strong as in the 4-inch bar.

The semi-elliptic bar exceeded the 4-inch bar, although taken out of it. The parabolic bar came near it. The bar made fast at both ends, I suspect must have yielded, although the ends were made fast by iron straps. The experiments from Emerson on solids of different forms might be made; but the time and trouble these experiments have already cost, have compelled me to relinquish further pursuits for the present. If, however, in the absence of better, they are worthy of the indulgence of the Royal Society, it will not only be a consolation to me that my labours merit their attention, but a further inducement to prosecute the investigation of useful facts, which even in the present advanced state of knowledge will yet admit of addition.

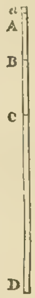
It has been observed by professer Leslie, that the strength of materials is exerted in four different ways: 1. In sustaining a longitudinal tension; 2. In withstanding a longitudinal compression; 3. In resisting a transverse pressure; and, 4. In opposing the act of twisting or wrenching

1. *Longitudinal Tension.*—The tension which a stone pillar, a bar of metal, a beam of wood, or even a hempen rope, can bear when pulled lengthwise, must evidently depend upon the cohesion of any cross section. As the material stretches out, the longitudinal attraction of the particles becomes augmented. This increase, at first, is proportional to the dilatation, but it afterwards advances very slowly, and a small additional strain is then sufficient to produce that limit of extension which occasions total fracture or disruption of the column. Its length will nowise affect the utmost strain which it can bear, this being determined merely by the smallest cross section where the dislocation of the particles will take place.



Let Z A be a prism stretched in the direction of its length. The particles of the section B will be pulled from those of the section C, till an attraction be generated equal to the whole tension. But the particles of the section C, must settle in equilibrium, and are consequently drawn back by an equal force. In this acquired position, therefore, they must attract the particles of the section D with the same force. The original tension is thus transferred successively to the extremity Z, where it is finally exerted, the effect of its action being neutralized in all the intermediate sections.

The cohesive power thus evolved, is hence the accumulative attraction of all the particles in any section. The corresponding longitudinal distention is at first proportional to it, but afterwards increases in a more rapid progression. Thus, a bar of soft iron is found to stretch uniformly, by continuing to append to it equal weights, till it be loaded with half as much as it can bear; beyond that limit, however, its extension will be doubled by each addition of the eighth part of the disruptive force. Supposing the bar to be an inch square and 1000 inches in length, 36,000 lbs. avoirdupois would draw it out 1 inch: but 45,000 lb. would stretch it 2 inches; 54,000 lbs. 4 inches; 63,000 lb. 8 inches; and 72,000 lb. 16 inches; when it would finally break, the extension being now eight times greater than its ordinary rate.



Let A B in the annexed figure be a prism or bar of any material, and its prolongation B C express the whole longitudinal force exerted, which occasions the small extension A *a*. While the length of this bar B C continues the same, it is evident that *a* A must be proportional to the distraining weight B C. Make, therefore, *a* A : B C : : A B : C D; or, alternately, *a* A : A B : : B C : C D, and C D must be constant. Since B C now bears the same relation to C D as *a* A to A B, any portion of C D will, by its weight, produce a corresponding distension of A B. Thus a column of the thousandth part of the length of C D would extend A B one thousand part, and the same weight would, by its compression, occasion an equal contraction. The column C D thus found is called the *Modulus of Elasticity*; it depends entirely on the nature of the cohesive substance, and may be determined by a single experiment.

Of the principal kinds of timber employed in building and carpentry, the annexed table will exhibit their respective modulus of elasticity, and the portion of it which limits their cohesion, or which lengthwise would tear them asunder.

| | | |
|---|---|---|
| Teak, | 6,040,000 feet, | 168th. |
| Oak, | 4,150,000 feet, | 144th. |
| Sycamore, | 3,860,000 feet, | 108th. |
| Beech, | 4.180,000 feet, | 107th. |
| Ash, | 4,617,000 feet, | 109th. |
| Elm, | 5,680.000 feet, | 146th. |
| Memel Fir, | 8,292.000 feet, | 205th. |
| Christiana Deal, | 8,118,000 feet, | 146th. |
| Larch, | 5,096,000 feet, | 121st. |

A tabular view may likewise be given of their absolute cohesion, or the load which would rend a prism of an inch square, and the altitude of the prism which would be severed by the action of its own weight.

| | | |
|---|---|---|
| Teak, | 12,915 lb. | 36,049 feet. |
| Oak, | 11,880 lb. | 32,900 feet. |
| Sycamore, | 9.630 lb. | 35,800 feet. |
| Beech, | 12,225 lb. | 38,940 feet. |
| Ash, | 14,130 lb. | 42,080 feet. |
| Elm, | 9,720 lb. | 39,050 feet. |
| Memel Fir, | 9,540 lb. | 40,500 feet. |
| Christiana Deal, | 12,346 lb. | 55.500 feet. |
| Larch, | 12,240 lb. | 42,160 feet. |

It is singular, that woods of such diversified structure should yet differ so little on the whole in their elasticity and cohesion. Specimens of the same sort will occur, which are sometimes as much varied as the several kinds themselves. The modulus of the elasticity of hempen fibres has not been ascertained, but may probably be reckoned about 5,000,000 feet. Their cohesion is, for every square inch of transverse section, 6,400 lb. The usual mode of estimating the strength of a cable or rope of hemp, is to divide by five the square of its number of inches in girth, and the quotient will express in tons the utmost strain it could bear. But the computation is rather simpler, to double the square of the diameter of the rope. This estimate, however, applies only to new ropes formed of the best materials, not much twisted, and having their strands laid even. If yarns of 180 yards long be worked up into a rope of only 120 yards, it will lose one-fourth of its strength, the exterior fibres alone resisting the greatest part of the strain. The register cordage of the late Captain Huddart exerts nearly the whole force of the strands, since they suffer a contraction of only the eighth part in the process of combining.

The metals differ more widely from each other in their elastic force and cohesive strength, than the several species of wood or vegetable fibres. Thus the cohesion of fine steel is about 135,000 lb. for the square inch, while that of cast lead amounts only to about the hundred and thirtieth part, or 1800lb.

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[*] That a square bar was weakest in the direction of its diagonal, I had from theory determined some time ago, and the investigation is given in the Phil. Mag. vol. L. p. 418; and it is very satisfactory to find it confirmed by these experiments, and also by those of Mr. Barlow.

It is not an easy task to make accurate experiments on triangular bars, as it is difficult to protect the angle, unless a kind of saddle be used, which must affect the result.—T. T.

[†] The science of construction is yet in its infancy, and certainly requires many additions. The first experiments on the strength of materials appear to have been made before the Royal Society; and there can be no doubt that a favourable reception will be given to any others that will tend to elucidate a subject, which is likely to form one of the principal branches of an engineer's education: as he must either proceed on the principle of science, or be directed by a feeling of fitness, which is to be acquired only by devoting a life-time to the practice of his art. It is to be hoped that Mr. Rennie will speedily bring forward some additions to the valuable experiments he has already made, with more detailed descriptions of the phenomena observed in the course of his labours. The example of the chemists ought to be followed, as it is not the number but the accuracy and correct description of experiments that constitute their value. Mr. Barlow has represented some of the fractures in his experiments by engravings, which is certainly an excellent plan.

In Evelyn's *Sylva*, (Dr. Hunter's edition, vol. ii. p. 227,) it is stated, that a treatise on duplicate proportion was published by Sir William Petty, in which is "A new hypothesis of elastic or springy bodies, to shew the strengths of timbers, and other homogeneous materials, applied to buildings, machines, &c." I have never been able to procure the work; but if any of your correspondents could furnish a sketch of this "new hypothesis," it would be a desirable addition to the history of this branch of science; as, if it should accord with Evelyn's description, our countryman will rank amongst the first contributors to the resistance of solids.—T. T.

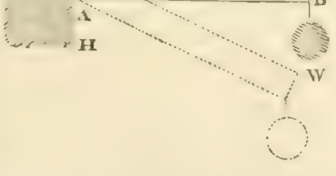
According to the very accurate experiments of George Rennie in 1817, and already noticed, the cohesive power of a rod an inch square, of different metals, in pounds avoirdupois, with the corresponding length in feet, is as follows :

| | | |
|---|---|---|
| Cast Steel,............ | 134,256 lb. ...... | 39,455 feet. |
| Swedish Malleable Iron, | 72,064 lb. ...... | 19,740 feet. |
| English ditto, ........ | 55,872 lb. ...... | 16,938 feet. |
| Cast Iron, ............ | 19 036 lb. ...... | 6,110 feet. |
| Cast Copper,.......... | 19,072 lb. ...... | 5,003 feet. |
| Yellow Brass, ........ | 17,958 lb. ...... | 5,180 feet. |
| Cast Tin, ............ | 4,736 lb. ...... | 1,196 feet. |
| Cast Lead,............ | 1,824 lb. ..... | 348 feet. |

It thus appears, that a vertical rod of lead, 348 feet long, would be rent asunder by its own weight. The best steel has nearly twice the strength of English soft iron, and this again is about three times stronger than cast iron. Copper and brass have almost the same cohesion as cast iron.

2. *Longitudinal Compression.*—The compression which any column suffers is at first equal to the dilatation occasioned by an equal and opposite strain, being in both cases proportional to the modulus of elasticity. But while the incumbent weight is increased, the power of resistance likewise augments, as long as the column withstands inflexure. After it begins to bend, a lateral disruption soon takes place. A slender vertical prism is hence capable of supporting less pressure than the tension which it can bear. Thus a cube of English oak was crushed only by the load of 3860lb. but a bar of an inch square and 5 inches high gave way under the weight of 2572lb. It would evidently have been still feebler if it had been longer. On the other hand, if the breadth of a column be considerable in proportion to its height, it will sustain a greater pressure than its cohesive power. Thus, though the cohesion of a rod of cast iron of the quarter of an inch square is only 300 lb., a cube of that dimensions will require 1440 lb. to crush it.

In general, while the resisting mass preserves its erect form, the several sections are compressed and extended by additional weight, and their repellent particles are not only brought nearer, but multiplied. This repulsion is likewise increased by the lateral action arising from the confined ring of detrusion. The primary resistance becomes hence greatly augmented in the progress of loading the pillar.



3. *Transverse or Lateral Pressure.*— Suppose the beam A B (in the annexed figure) to have one end firmly implanted in a wall G H, and a vertical pressure applied at the other end. This beam, sinking under the load at B, may be conceived to turn on the lowest point at A as a fulcrum; consequently the particles of the vertical section A C will be forced into the oblique position A D, each of them being turned aside through a space proportional to its distance from A. The strain exerted at the end A C will therefore be the result of the aggregate dislocations of all the particles of the section. When the breadth and length of the beam remain the same, this accumulate strain must evidently be proportional to the area of the triangle C A D, and consequently to the square of the depth A C. But when the breadth of the beam is taken likewise into account, the triangle of tension becomes converted into a wedge, and the strain hence follows the direct ratio of that breadth. Omitting the weight of the beam, and assuming its depth and breadth as constant, the tension of any particle at C may be considered as acting against the short arm A C of the rectangular beam C A B, and withstanding the load suspended at B. The weight thus resisted by the cohesion of the beam, is therefore inversely as the length A B. Combining all these circumstances, we conclude, that the strength of a beam firmly inserted in a wall, or its power to resist a pressure at its remote extremity, is compounded of the direct ratios of its breadth, and of the square of its depth, and the inverse ratio of its length. Thus, a beam having the same length and breadth as another, but twice the depth, is four times stronger; and a beam of the same depth and breadth, and double the length, is only half so strong. Hence also, a beam, whose depth is triple its width, will sustain a load three times greater. For the same reason, a square prism will have its strength inversely as its length and the cube of its thickness. In general, the resistance of a beam of any form, but of a given length, to a cross strain, will be the same as if the whole power exerted were collected in the centre of gravity of each section. Thus, the strain of a triangular prism may be conceived as concentrated in a point at one-third of the distance of the perpendicular from the vertex to the base. Such a prism is therefore twice as strong set on its edge as when laid on its side. This simple investigation we owe to Galileo, and, though partly hypothetical, it is a near approximation to the truth. It is of essential service in improving the practice of carpentry, and sheds a clear light over the economy of nature in the structure of animals and vegetables. Reeds and herbaceous plants derive their power of resisting the wind, from the subdivision of their length into moderate intervals by hard knots. But they acquire still greater strength from their tubular form; for the matter they contain, being thus removed to a greater distance from the fulcrum, exerts its cohesion with proportionally more effect, in withstanding any lateral impulsion. The bones of animals are likewise rendered stronger by their fistular structure, and their partition into short members connected by large compact joints. Hence, in the construction of fine mechanical and astronomical instruments, hollow brass cylinders, on account of their stiffness and lightness, are now preferred to solid pillars. If a beam be supported horizontally at both ends, and loaded in the middle, the pressure will be equally shared between the props; the effect is the same as if it were fixed at the middle, and each end pulled upwards by half its load. The breaking weight is consequently double that required to tear a beam, of half the length, implanted in a wall. According to the principle of Galileo, therefore, this limit is inversely as the length of the beam, and directly as the breadth and the square of the depth. This result is confirmed by the numerous experiments which Buffon performed between the years 1738 and 1746. Thus, reducing all the quantities to English measures, an oaken beam, 4 inches square and 10 feet long, broke under the weight of 4015lb.; and another beam of the same wood, 8 inches square and 20 feet long, was broken by a load of 16,700 lb. The latter, being twice as thick, should have been eight times stronger with the same length; but the length being doubled, again reduced the excess to four times.

4. *In its Resistance to the Effort of Twisting or Torsion.*—A cylindrical body suspended vertically, but having its upper end fixed, may be wrenched or turned round through any angle, by the exertion of some lateral force; and if its elasticity be not thus impaired, it will, after the deranging influence has ceased, return to its former position, and perform this retrocession in a certain time. Many substances may be considered as only bundles of parallel fibres, which by twisting exert an augmented longitudinal force. It will be more accurate, however, to view materials in general as composed of particles equally distributed through the mass.

STREPITOSUS, the name of a disease common to the inhabitants of some parts of the Alps, in which the face, neck, and arms are so distended with flatulencies as to sound, on being struck, like a dry bladder half distended with wind.

STRETCHER, a narrow piece of plank placed athwart the bottom of a boat, for the rower to place his feet against, in order to communicate a greater effort to his oar.

STRETCHING, is generally understood to imply the progression of a ship under a great surface of sail, when close hauled. The difference between this phrase and standing, is apparently in the quantity of sail, which, in the latter, may be very moderate, but in stretching generally implies considerable, as, 'We were standing in shore (under easy sail) when we discovered the enemy stretching to the southward,' that is, under a crowd of sail.

**STRIKE**, a measure of capacity, containing four pecks.

**Strike**, among Seamen, is a word variously used. When a ship, in a fight, or on meeting with a ship of war, lets down or lowers her top-sails at least half-mast high, they say she strikes, meaning she yields, or submits, or pays respect, to the ship of war. Also, when a ship touches ground, in shoal water, they say she strikes. And when a top-mast is to be taken down, the word of command is, Strike the top-mast, &c.

**STRING**, in Ship-building, the highest range of planks in a ship's ceiling, or that which lies between the gunwale and the upper edge of the upper-deck ports.

**STRIX**, *the Owl*, in Natural History, a genus of birds of the order of Accipitres. Birds of this genus are rapacious. They are seldom seen by day, secluding themselves in the hollows of trees and buildings, and unable, from the particular structure of the eye, to endure the glare of sunshine. When they do appear in the day, they are pursued and persecuted by a variety of small birds, who combine in their expressions of ridicule and aversion, and soon oblige them to recur again to their retreat. During the season of general repose, they are active in quest of food, which in darkness they perceive with facility, and disturb the silence of night by loud and reiterated screams. Their usual prey consists of bats, mice, and small birds. Latham enumerates forty, and Gmelin fifty species.

**STROKE**, a single sweep of the oars in rowing. Hence we say, 'Row a long stroke;' which is intended to move the vessel forward more steadily.

**STROKESMAN**, the person who rows the aftmost oar in a boat, and gives the stroke which the rest are to follow, so that all the oars may operate together.

**STRONTIAN**, about the year 1737, a mineral was brought to Edinburgh by a dealer in fossils, from the lead mine of Strontian, in Argyleshire, where it is found imbedded in the ore, mixed with several other substances. It is sometimes transparent and colourless, but generally has a tinge of yellow or green. Its specific gravity varies from 3·4 to 3·726. Its texture is generally fibrous; and sometimes it is found crystallized in slender prismatic columns of various lengths. Strontian is found abundantly in different places of the world, and always combined with carbonic acid, or sulphuric acid.

**STRONTIUM**, the metallic basis of strontia.

**STROP**, a piece of rope, spliced generally into a circular wreath, and used to surround the body of a block, so that the latter may be hung to any particular situation about the masts, yards, or rigging. Strops are also used occasionally to fasten upon any large rope for the purpose of hooking a tackle to the eye or double part of the strop, in order to extend or pull with redoubled effort upon the same rope; as in setting up the rigging, where one hook of the tackle is fixed in a strop applied to the particular shroud, and the other to its laniard.

**STRUTHIO**, *the Ostrich*, in Natural History, a genus of birds of the order Gallinæ. The black ostrich, is about eight feet long, and when erect measures about seven feet, and sometimes eight in height. One was exhibited in London in 1750, weighing three hundred pounds. It is found in various parts of Africa, and about the Cape of Good Hope is particularly abundant. In the parts of Asia, near Africa, it is also met with. The ostrich subsists entirely on vegetable productions, but will swallow, occasionally, the most hard and even sharp-pointed substances. Iron, and various other metals, and even glass, have often been found in its stomach, and have unquestionably often proved fatal. It is related, upon respectable authority, that an ostrich will carry a man upon his back, and move with very considerable speed: some make the same remark with respect to two men. When unencumbered by any burden, its speed is truly extraordinary, and will exceed, in some instances, the ordinary rapidity of a horse. Dogs are sometimes employed to hunt them down, followed by men on horseback, who contrive, by means of a long hooked staff, to lay hold of one of the legs of the bird, and thus bring it to the ground. They are applied to various purposes. Their feathers form an admirable ornament for the ladies; their skins are of sufficient thickness to be manufactured for the purpose of leather.—The galeated cassowary, is nearly equal in magnitude to the ostrich, but has a much shorter neck, and therefore is greatly inferior in height. On the top of its head is a species of helmet three inches high, and one thick at the base. Each wing, or what appears as such, is destitute of feathers, and has five bare shafts like those of the porcupine, and the body is covered with loose webbed feathers of a rusty black colour. It is never found beyond the tropical limits, and is no where abundant within them. It is unable to fly, but runs with great speed; and though it lives only on vegetables and fruits, which it is said to swallow unbroken, it is courageous, and even sometimes ferocious, and employs its legs to annoy its adversary by kicking.—The New Holland cassowary, is very similar to the above, but considerably longer.

**STRYCHNIA**, a newly-discovered vegetable alkali. MM. Pelletier and Caventon, whilst analyzing the vomica nut, and the bean of St. Eustatia, have extracted from these two seeds a substance to which they owe their action on the animal economy.

**STUB**, in Agriculture, a term signifying the root of a plant, with the top cut off. *To Stub*, is to grub up the roots or stumps of trees, shrubs, or brushwood, left in the ground after the tops are cut off.

**STUBBLE**, the strawy matter of the cut stalks, or stems of grain, remaining in the ground after reaping. In some parts of Essex, when mixed with much grass and weeds, it is burnt in the field. This tends to destroy the weeds, and the ashes become manure.

**STUCCO**, in Building, is a composition of white marble pulverized, and mixed with plaster or lime, the whole sifted and wrought up with water, to be used like common plaster. Of this composition are made statues, busts, basso relievos, and other architectural ornaments. A stucco for walls, &c. may be formed of the grout or putty made of good stone-lime, or the lime of cockle-shells, which is better, properly tempered and sufficiently beat, mixed with sharp grit-sand, in a proportion which depends on the strength of the lime: drift-sand is best for this purpose, and it will derive advantage from being dried on an iron plate or kiln, so as not to burn; for thus the mortar would be discoloured. When this is properly compounded, it should be put up in small parcels against walls, or otherwise, to mellow, as the workmen term it; reduced again to a soft putty, or paste, and spread thin on the walls without any under-coat, and well trowelled. A succeeding coat should be laid on, before the first is quite dry, which will prevent joints of brick-work appearing through it. Much depends upon the workmen giving it sufficient labour, and trowelling it down. If this stucco, when dry, is laid over with boiling linseed oil, it will last a long time, and not be liable, when once hardened, to the accidents to which common stucco is liable.

Liardet's, or, as it is commonly called, Adam's oil-cement, or stucco, is prepared in the following manner: For the first coat, take twenty-one pounds of fine whiting, or oyster-shells, or any other sea-shells calcined, or plaster of Paris, or any calcareous material calcined and pounded, or any absorbent material whatever, proper for the purpose; add white or red lead at pleasure, deducting from the other absorbent materials in proportion to the white or red lead added; to which put four quarts, beer-measure, of oil; and mix them together with a grinding-mill, or any levigating machine: and afterwards mix and beat up the same well with twenty-eight quarts, beer-measure, of any sand or gravel, or of both, mixed and sifted, or of marble or stone pounded, or of brick-dust, or of any kind of metallic or mineral powders, or of any solid material whatever, fit for the purpose. For the second coat, take sixteen pounds and a half of superfine whiting, or oyster-shells, or any sea-shells calcined, &c. as for the first coat; add sixteen pounds and a half of white or red lead, to which put six quarts and a half of oil, wine-measure, and mix them together as before: afterwards mix and beat up the same well with thirty quarts, wine-measure, of fine sand or gravel sifted, or stone or marble pounded, or pyrites, or any kind of metallic or mineral powder, &c. This composition requires a greater proportion of sand, gravel, or other solids, according to the nature of the work, or the uses to which it is to be applied. If it be required to have the composition coloured, add to the above ingredients such a proportion of painter's colours as will be necessary to give the teint or colour required. In making the composition, the best linseed or hempseed, or other oils proper for the purpose, are to be used, boiled or raw, with drying ingredients, as the nature of the work, the season, or the climate, requires; and in some cases, bees-wax may be substituted in place of oil: all the absorbent and solid materials must be kiln-dried. If the composition is to be of any other colour than white, the lead may be omitted, by taking the full proportion of the other absorbents; and also white or red lead may be substituted alone, instead of any other absorbent material. The first coat of this composition is to be laid on with a trowel, and floated to an even surface with a rule or darby, (*i. e.* a handle-float.) The second coat, after it is laid on with a trowel, when the other is nearly dry, should be worked down and smoothed with floats edged with horn, or any hard smooth substance that does not stain. It may be proper, previously to laying on the composition, to moisten the surface on which it is to be laid, by a brush with the same sort of oil and ingredients which pass through the levigating machine, reduced to a more liquid state, in order to make the composition adhere the better. This composition admits of being modelled or cast in moulds, in the same manner as plasterers or statuaries model or cast their stucco work. It also admits of being painted upon, and adorned with landscape, or ornamental, or figure-painting, as well as plain painting. For the invention of this stucco, Mr. Liardet obtained a patent in 1773 for fourteen years, the term of which was extended to eighteen years, in consequence of an act of parliament in 1776. For compositions very similar to the preceding, patents were granted to Dr. Wark in 1765, Mr. Emerton in 1771, and to Mr. Rawlinson in 1772.

Dr. Shaw informs us in his Travels, (p. 286,) that the cement or mortar used in Barbary, which is apparently of the same consistence and composition with that of the ancients, is made in the following manner: They take two parts of wood-ashes, three of lime, and one of fine sand, which, after being well sifted and mixed together, they beat for three days and nights incessantly with wooden mallets, sprinkling them alternately and at proper times with a little oil and water, till they become of a due consistence. This composition, he adds, is chiefly used in their arches, cisterns, and terraces; but the pipes of their aqueducts are joined, by beating tow and lime together with oil only, without any mixture of water. Both these compositions quickly assume the hardness of stone, and suffer no water to pervade them; and will, therefore, answer the purpose of stucco.

**STUDDING-Sails**, certain sails, extended in moderate and steady breezes beyond the skirts of the principal sails, where they appear as wings to the yard-arms. The top-mast and top-gallant studding-sails are those which are set on the outside of the top-sails and top-gallant-sails. They are spread at the foot by booms, which slide out on the extremities of the lower and top-sail yards, and their heads or upper edges are attached to small yards, which are hoisted up to the top-sail and top-gallant yard-arms. The lower studding-sails, which are spread beyond the leeches of the main-sail, are fixed nearly in the same manner, only that the boom which extends the foot is hooked to the chain by means of a goose-neck, or else swings off with the sail to which it is suspended, being kept steady abaft by a rope called the guy.

**STUFF**, in Commerce, is a general name for all kinds of fabrics of gold, silver, silk, wool, hair, cotton, or thread, manufactured on the loom; of which number are velvets, brocades, mohair, taffeties, cloth, serges, &c. The term is also used more particularly to denote slight woollen articles used principally for linings and women's apparel.

Stuff, any composition or melted mass, used to smear or daub the sides or bottom of a ship. The stuff which is chiefly used for the lower masts, is simply turpentine, resin, or varnish of pine; for the top-mast, tallow or butter; for the sides, turpentine, varnish of pine, tar and oil, or tar mixed with oil and red ochre; and for the bottom, a mixture of tallow, sulphur, and resin or tar, whale oil and broken glass, or any part of these ingredients; and this application is called giving a new coat of stuff to the masts, sides, &c.

**STUM**, in the Wine Trade, is a name for the unfermented juice of the grape, when it has been several times racked off, and separated from the sediment. The casks are for this purpose well fumigated with brimstone, in order to prevent fermentation, through which the juice would become wine. *See* Matching.

**STUMP**, a name given to the root part of any solid body, particularly of trees, remaining after the rest are taken away.

**STUPA**, a numbness occasioned by any bandage that stops the motion of the blood and nervous fluids, or by a decay in the nerves, as in paralytic strokes, &c.

**STURDY**, a disease very prevalent among sheep, and which terminates fatally if not relieved in its early stages.

**STURGEON**, a well-known, large, and fine-tasted fish, which spends part of its time in rivers and part in the sea.

Sturgeon. *See* Accipenser.

**STYCHNOS**, in Botany, a genus of the pentandria monogynia class and order. Natural order of Luridæ apocineæ, Jussieu. There are three species; we shall notice the S. nux vomica, poison nut. It is a native of the East Indies, and is common in almost every part of the coast of Coromandel, flowering during the cold season. The wood is hard and durable, and is used for many purposes by the natives. The root is used to cure intermitting fevers, and bites of venomous snakes. The seed of the fruit is the officinal nux vomica.

**STYLE**, a word of various significations, originally deduced from a kind of bodkin, wherewith the ancients wrote on plates of lead, or on wax, &c. and which is still used to write on ivory leaves, and paper prepared for that purpose, &c.

Style, in Chronology, denotes a particular manner of accounting time. Style is either old or new. The old style is that mode of computing time which is called the Julian, and is still followed in some states, that refuse to admit the reformation of the calendar. The new style is that of Gregory XIII. which is followed by the Catholics, and by most Protestant kingdoms.

Style, in Dialing, denotes the gnomon of a dial, raised on the plane of it, to project a shadow.

Style, in Grammar, is a particular manner in which individuals express their thoughts either in writing or speech, agreeably to the rules of syntax. *Style* has various other acceptations, as applied to music, oratory, poetry, philosophy, mathematics, &c.

Stylet. *See* Stiletto.

**STYPTIC**, a remedy that has the virtue of stopping blood, or of binding up the aperture of a wounded vessel. Many waters and powders are of this description; but in most, vitriol is the chief ingredient.

**STYRAX**, the *Storax Tree*, a genus of plants belonging to the class of decandria, and to the order of monogynia, and in the natural system ranging under the 18th order, bicornes.

**SUBALTERN**, an inferior officer, who discharges his post under the command of another, to whom his duty is to yield obedience.

**SUBERATS**, salt formed with the suberic acid.

**SUBERIC ACID**, an acid obtained from cork.

**SUBJECT**, in Legislation, a person under the dominion of a sovereign prince or state. Under the feudal system, those who held lands or tenure under the barons were deemed their subjects. In Anatomy, a body obtained for dissection is called a subject. In Logic, subject is that about which the thoughts and understanding are employed.

Sublimate. *See* Corrosive Sublimate.

**SUBLIMATION**, in Chemistry, an operation by which volatile substances are collected and obtained. It is nearly allied to distillation, excepting that in the latter the fluid parts only of bodies are raised, whereas in sublimation the solid and dry are collected.

**SUBLIMITY**, a term applicable to external objects, whether works of nature or of art, as well as to powerful language, and, in short, to whatever is calculated to raise grand, terrible, and magnificent ideas. It elevates the mind above ordinary scenes, and fills it with wonder and astonishment.

**SUBMULTIPLE**, in Geometry, is a number or quantity contained in another, which being repeated a given number of times, becomes exactly equal to it. Thus 3 is a submultiple of 21.

**SUBNORMAL**, in Geometry, is a line which determines the point, in the axis of a curve, where the normal or perpendicular, raised from the point of contact of a tangent to the curve, cuts the axis.

SUBORNATION, a secret or underhand preparing or instructing a witness to give a false testimony. It is defined as an act that allures or disposes to perjury.

SUBPŒNA, is a writ whereby all persons under the degree of peers are called into Chancery, in such case only where the common law fails, and has made no provision; so as the party who in equity hath wrong, can have no other remedy by the rule and course of common law. It is therefore the commencement of a suit in equity. But the peers of the realm in such cases are called by the lord chancellor's or lord keeper's letters, giving notice of the suit intended against them,and requiring them to appear. There is also a *subpœna ad testificandum*, or a subpœna to give evidence for the summoning of witnesses, as well in Chancery as other courts. There is also a subpœna in the Exchequer, as well in the court of equity there, as in the office of pleas; which latter is a writ that does not require personal service, and is the commencement of a suit at common law.

SUBSCRIPTION, in Civil concerns, is the signature put at the bottom of a letter, writing, or instrument.

Subscription, in Commerce, is used for a share which particular persons hold in a public stock, or a trading company.

Subscription, in the Book Trade, is an engagement to take a given number of copies, on some stated terms. Subscription to the thirty-nine articles of religion, is a solemn declaration of the subscriber's assent to the doctrines and precepts they contain.

SUBSIDY, in Law, signifies an aid or tax granted to the king by parliament, for the necessary occasions of the kingdom.

SUBSTANCE, something that is capable of subsisting without dependence upon any created being, or any particular modes or accidents. There are but two kinds of substance known to exist, namely, matter and spirit. The former is distinguished by its magnitude, extension, &c. and the latter by its consciousness, understanding, and volition.

SUBSTANTIVE, in Grammar, a noun, or name, considered simply and in itself.

SUBSTITUTE, a person appointed to officiate for another in case of absence, legal impediment, or agreement.

SUBTANGENT of a Curve, in the higher Geometry, is the line which determines the intersection of the tangent with the axis; or, that determines the point wherein the tangent cuts the axis prolonged.

SUBTENSE, in Geometry, the same with the chord of an arch.

SUBTILE, in Physics, a thing remarkably small, fine, and delicate, such as the animal spirits, or the effluvia of odorous bodies, are supposed to be. The Cartesians suppose a very subtile matter to be the first element of their system.

SUBTRACTION. *See* Arithmetic.

SUBULARIA, rough-leaved alysson, or awlworth, a genus of plants belonging to the class of tedradynamia, and order of siliculosa; and in the natural method ranking under the 39th order siliquosæ.

SUBURBS, buildings which stand near to the walls or specific boundaries of a city or town, but are not included within their compass.

SUCCINATS, salts formed with the succinic acid; which see.

SUCCINIC ACID. Amber is a well-known, brown, transparent, and inflammable body, pretty hard, and susceptible of polish, found at some depth in the earth, and on the sea coast of several countries

SUCTION, in Physiology, the act of drawing into the mouth fluids, and other substances, by removing from the part where the operation is performed, the pressure of the external atmosphere, whilst on every other portion all its power remains unobstructed. Suction is little more than the formation of a partial vacuum, into which, when made by the mouth or otherwise, the fluid immediately flows.

SUFFERANCE. Tenant at sufferance, is he who holds over his term at first lawfully granted. A person is tenant at sufferance who continues after the estate is ended, and wrongfully holds against another, &c.

SUFFOCATION, the termination of life by impeded respiration. This may be occasioned three ways, by hanging, drowning, or by carbonic acid gas.

SUFFRAGAN, a titular bishop, appointed to aid and assist the bishop of the diocese.

SUGAR, Saccharum, a very sweet, agreeable, saline juice, expressed from a kind of canes, or reeds, growing in great plenty in the East and West Indies. Pure sugar is perfectly transparent and colourless, when crystallized; but when granular, of a pure gloss of white, soluble in water and alcohol, without smell, and with a simply sweet taste, having no other flavour.

It is a question not yet decided among botanists, &c. whether the ancients were acquainted with this cane, and whether they knew how to express the juice from the same? What we can gather from the arguments advanced on either side is, that if they knew the cane and juice, they did not know the art of condensing, hardening, and whitening it; and of consequence, they knew nothing of our sugar.

Dr. William Douglas, in his Summary, &c. of the first planting of our American settlements, printed at Boston in 1751, and reprinted at London in 1755, affirms, that sugar was not known among the ancient Greeks and Romans, who used only honey for sweetening. Paulus Ægineta, he says, a noted compiler of medical history, and one of the last Greek writers on the subject, about anno 1625, is the first who expressly mentions sugar: it was at first called *mel arundinaceum*, i. e. *reed* or *cane honey*. He adds, that it came originally from China, by way of the East Indies and Arabia, into Europe, and was formerly used only in syrups, conserves, and such Arabian medicinal compositions.

Another question among the naturalists is, Whether the sugar-cane be originally of the West Indies, or whether it has been translated rather from the East? The learned of these last ages have been much divided on the point; but F. Labat, a Dominican missionary, in a dissertation published in 1722, asserts that the sugar-cane is as natural to America as India; and that the Spaniards and Portuguese first learned from the Orientals the art of expressing its juice, boiling it, and reducing it into sugar.

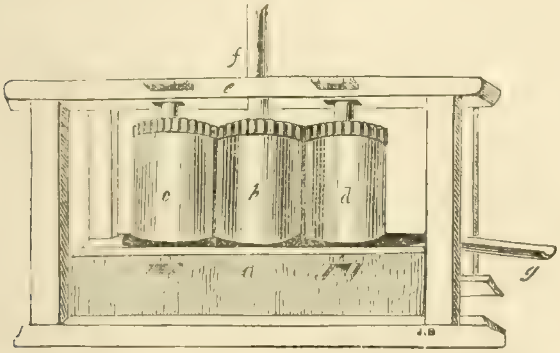
Sugar *Cane*, in Botany. *See* Saccharum.

The root of this plant is jointed like those of the other sorts of canes and reeds, from which arise four, five, or more shoots, according to the age or strength of the root: these grow from eight or ten to twenty feet high, according to the richness of the ground; but those of middling growth are the best. The canes are also jointed, and the length, as well as the size of the joints, depend upon the weather and the soil; at each joint are placed leaves, the lower part of which embraces the stalk or cane to the next joint above their insertion, before they expand. The first joint, which comes out either at the third, fourth, or fifth month, according to the season and soil, always keeps in its first place near the earth; out of this comes the second, and out of the second a third, &c. each week producing its joint, or very nearly, and a corresponding leaf likewise drying and falling off nearly every week. A cane of thirty-two joints, which is fit to be cut, has from five to twenty-eight of them which have lost their leaves; the next five or six still have them, in a withered state, and ready to fall off; and the remaining joints, surrounded with green leaves, from the head, which is cut off after the leaf is withered. In a cane, whose length is from seven to nine feet, and which grows in a new, or a very moist and favourable soil, the number of useful joints is between forty and fifty, the first above the ground generally appearing at the end of three months, or, with frequent showers, a fortnight sooner; and many canes in such a soil are found rotten, or almost dried up, at the end of thirteen months: in a good soil, favourably exposed, well drained, and worked for a number of years, canes not shorter than four feet and a half have thirty-eight or forty joints, the first joint appearing about the fourth, or middle of the third month, and many canes that have been cut in such a soil at the end of fourteen or fifteen months, being found rotten or dried: in a dry, but good soil, not manured, but well worked, and seconded by the season, the canes have been from three to four feet long, and have had from thirty to thirty-four joints; the first joint coming out at the end of four, or four months and a half; and canes of this kind have been found standing at the end of fifteen months, but very dry, and sometimes a little changed: in a soil which is still drier, and more parched, canes which have been about two feet high, have had from twenty-four to twenty-eight joints, the first of which appears at the end of the fifth month, and many of these canes have been dried at the end of fifteen months.

The time for cutting them is usually after twelve or fifteen months' growth, but this varies according to the soil and the season. Those which are cut toward the end of the dry season, before the rains begin to fall, produce better sugar than those cut in the rainy seasons, when they are more replete with watery juice, and require a greater expense of fuel to boil it. In those plantations where the number of negroes is small, sugar is made in almost all seasons indifferently, and consequently the canes are planted when the planter is best prepared for his work, rather than at the most advantageous time. The system of cultivation among planters who are better supplied in respect of labourers, consists in planting a fourth or fifth of their land in October, November, and December; in digging very deep trenches, for the greater nourishment of the root; in planting at great distances, for the benefit of a freer circulation of the air; and in cutting the canes in the four finest months, *viz.* February, March, April, and May, because the sugar is then the finest, the canes are cut with the least trouble, and supply (as is supposed) greater quantities of it. Those who adopt this method, cut about three-fourths of their plantations, the remaining being made up of young canes, to be cut the following year, and for new plants.

The manure generally used in sugar planting, is a compost formed of the coal and vegetable ashes drawn from the fires of the boiling and still houses; feculences discharged from the still house, mixed with rubbish of buildings, white lime, &c.; refuse, or field trash, *i. e.* the decayed leaves and stems of the canes, so called in contradistinction to cane trash used for fuel; dung, obtained from the horse and mule stables, and from cattle pens; and good mould, collected from gullies, or other waste places, and thrown into the cattle pens.—When the rattoons or canes are ripe, as they ordinarily are in twelve or fifteen months, or, as Mr. Cazaud apprehends, in eleven or twelve months, they are cut, and carried in bundles to the mill.

SUGAR, *Making of.*—When the plants have attained their full growth, which, in the West Indies, is from twelve to fourteen months, the canes are cut short, tied up into bundles, and brought to the Crushing Mill, of which the following is a representation of those in common use.



*Description.*—A large block, *a*, is enclosed by a strong frame of timber; the upper surface of this block is hollowed out into the form of a basin, to receive the juice of the canes, which is expressed by the three vertical cylindrical rollers *c, b, d,* whose lower pivots work in sockets which are fixed in the block *a*, and the upper in *e*. The upper and lower sockets, in which the pivots of the middle roller revolve, are fixed immoveably; but the sockets of the other two are held between wedges, (as shewn in the engraving,) which are put in contrary directions, the small end of one wedge being on the same side as the large end of the other; by which means the rollers may be either set farther from or nearer to each other. When it is required to set the outside rollers nearer to the middle roller, that wedge which is nearest the middle roller is to be driven out, and the other driven in; and the contrary when they are wanted farther asunder. These rollers are usually made of cast iron, having each a cog wheel at the upper end on the same shaft, which causes them all to turn together, when the power of a first mover is applied to the middle roller, by the shaft *f*.

Behind the middle roller is a circular or concave piece of iron or wood, (not shewn in the above engraving) which is called the dumb returner, a name obviously given to the circumstance of a man being always employed, previous to the invention of this part of the apparatus, to perform the same office. In working the mill, a man takes a bundle of the canes, and applying them between the first and second rollers, (*c* and *b*) they are drawn in and pressed between them, but instead of proceeding in a right line, the ends of the cane strike against the concave surface of the dumb returner, which bends them round the middle roller, and causes them to enter between the second and third rollers (*b* and *d*) which are placed somewhat nearer to one another than *c* and *b*, as the canes have already received great compression, and when they are thus returned through the front, they are received and carried off by another man. The expressed juice runs down the rollers into the reservoir, and is conveyed by the trough *g* to the boiling-house. It should be observed, that the reservoir on the top of the block *a* is only cut into channels round the outside of the rollers, to prevent the liquor running down and getting out betwen the wedges before mentioned. If a sugar mill be worked by the wind, the shaft *f* is connected with the vertical shaft of the mill. If by horses, the levers they work from are fixed to the shaft *f*, and the horse walk is either raised above ground higher than the trough, or the juice is conveyed by a pipe laid under the walk. Sugar-mills that are worked by a water wheel or steam-engine, have a bevelled wheel fixed upon the shaft *f*, and another upon the wheel or engine which turns it. Such is the pressure given to the canes in passing between the rollers of the mill, that they are not only squeezed completely dry, but are often reduced to powder. The refuse or macerated rind of the cane, which is called cane trash, serves for fuel to boil the liquor in the subsequent operations.

The sugar is obtained by the following process:—The juice from the mill runs from the receiver to the boiling house, along a wooden gutter lined with lead. In the boiling house it is received into one of the copper pans or caldrons, called clarifiers. Of these there are generally three; and their dimensions are determined by the power of supplying them with liquor: there are water mills that will grind with great facility, sufficient for thirty hogsheads of sugar in a week. Methods of quick boiling cannot be dispensed with on plantations thus fortunately provided; for otherwise the cane liquor would unfortunately become tainted before it could be exposed to the fire. The purest cane juice will not remain twenty minutes in the receiver without fermenting; hence clarifiers are sometimes seen of a thousand gallons each: but on plantations that during crop time make from fifteen to twenty hogsheads a week, three clarifiers of three or four hundred gallons each are sufficient. The liquor, when clarified, may be drawn off at once with pans of this size, and there is leisure to cleanse the vessels every time they are used. Each clarifier is furnished with a syphon or cock, to draw off the liquor clear and free from the scum which is thrown up during the boiling.

In order to assist in the separation of the gum, oil, and other vegetable principles which are intermixed in the expressed juice, and for the purpose of neutralizing the superabundant acid, a quantity of Bristol white lime, in powder, or in solution, is stirred into it, and in the proportions and manner of effecting this, according to the state of the liquor, consists one of the principal difficulties in sugar making. In this first process of clarification the liquor is not suffered to boil, but is allowed to do so when drawn off clear into the next pan, which is called the *evaporating copper*; here the ebullition is continued (and the froth or scum removed by skimmers as it rises) until it becomes of such a consistence, as to be reduced in quantity very considerably, so that it may be contained in a much smaller copper, into which it is next ladled. The liquor is now bright, and of the colour of Madeira wine. In this state, and of a certain consistency, it undergoes a farther evaporation in the vessel called the teach, until it is so far condensed as to be capable of granulating when cool. The next operation is that of striking, which consists in ladling the thick liquor into the cooler.

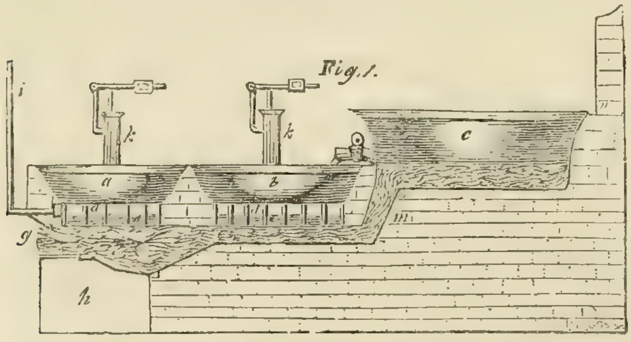
The cooler (of which there are usually six, is a shallow wooden vessel about eleven inches deep, seven feet in length, and from five to six feet wide, and is capable of holding a hogshead of sugar. Here the sugar *grains*, as it is called; *i. e.* it runs into a coarse irregular mass of imperfect crystals, separating itself from the molasses. From the cooler it is taken to the curing-house.

The curing house is a large airy building, provided with a capacious molasses cistern, the sides of which are sloped, and lined with terras or boards. A frame of massive joist work without boarding is placed over this cistern; and empty hogsheads without headings are ranged on the joists of this frame. Eight or ten holes are bored in the bottoms of these hogsheads, and through each of the holes, the stalk of a plantain leaf is thrust, six or eight inches below the joists, and long enough to stand upright above the top of the hogsheads. Into these hogsheads the mass from the coolers is put, which is called *potting*; and the molasses drains through the spongy stalks of the plantain leaves, and drops into the cistern beneath; from whence it is occasionally taken for the making of rum by distillation. In the space of three weeks the sugar becomes tolerably dry and fair; it is then said to be cured, and the process finished. Sugar thus obtained, is called the muscovado, and is the raw material whence the British sugar-bakers make their loaf or refined lump sugar.

Several methods of clarifying have been adopted, and are still in use; that, however, invented by Mr. Smith, and for which he obtained a patent, is entitled to a decided preference. The burning of the cane trash had been found injurious to the molasses, but his steam apparatus, represented in the engraving, completely remedies this defect.

*Reference to the Engraving.*—*a*, is the finishing pan, or teach, *b*, the evaporating copper, *c*, the clarifier; this last is gently heated by the flue *f* from the distant fires, *a* and *b* are heated by the same fire, through the medium of two separate steam boilers, *d d* and *e e* shews the depth of water they contain; *g* is the fire-door, *h* the ashpit, *i* the feed-pipe for supplying water when necessary, one of which is employed to each steam boiler. *k k* are safety valves for regulating the pressure of the steam, *n* the chimney. Cocks are fixed to each of the boilers for drawing off the water and the steam, which cannot be shewn in the sectional view. We shall now conclude by quoting some of the observations of the patentee on the subject. The bottom of the boilers is flat, and the spaces between them and the bottom of the sugar-pan forms the boiler, which need not exceed a foot in depth for the largest apparatus. If the pans project beyond the boilers, it will be found advantageous; for the sides being cooler than the other parts, the fluid is prevented from boiling over, and the scum, as it forms, is thrown on the sides, and collected with greater facility. The steam being applied to every part of the bottom of the pan, communicates its heat to the liquor therein, and being thereby condensed, descends in drops of water to the bottom of the boiler, and is again raised into steam by the heat of the fire underneath, so that the operation continually goes on, of generating and condensing in the same vessel, thus dispensing with force pumps and complicated feed pipes; however unequally the fire may act on the boiler, the effect on the bottom of the sugar pan is perfectly equalized by the intervening stratum of steam, an advantage peculiar to this apparatus. The steam boiler and sugar pan are made of thin copper, or iron; and to give sufficient strength to large surfaces, they are united by riveted bolts at short and equal distances, thus enabling thin metal to resist any required pressure of steam.

Fig. 1.



**Sugar**, *Refining of*, is the art of purifying sugar, and of giving a superior degree of whiteness and solidity. The excellence of muscovado sugars, or such as have not been refined by the planter, but are sent home in the most crude state, consists in their whiteness, dryness or freeness, cleanness and sharpness, or strength. The judicious refiner decides upon these several qualities by the eye, the touch, and the taste. The first operation in the process of refining is that of *clearing the pans*; previously to which they are charged, by throwing about six quarts of fresh bullock's blood (called spice) into each pan, and filling it with lime-water to about half the height from the bottom to the part in which the brace is fixed; and when these are well stirred together, the pan is filled to the brim with raw sugar. This mass, with a moderate fire, will, in about two hours, be brought to the verge of boiling heat; but it should not be allowed actually to boil; and in this time the earthy particles of the sugar, and other adventitious impurities, will be separated from it by the effect of the heat, and the cleansing quality of the spice, and thrown up to the surface. About two quarts of spice are added to each pan, within the first hour after the fires are lighted. The scum thus produced, which is usually from four to ten inches thick, is fit to be taken off, when the surface appears black and dry, and not greasy; and it is gently removed with a broad skimmer into a portable tub, and conveyed into the scum-cistern. Having done this, the panman stirs together a ladleful of spice, (*e. gr.* about a quart,) and a quantity of lime water (*e. gr.* one or two gallons, as the case may require); and pours this mixture into each pan. When the sugar is again brought to a scalding heat, it throws up a second scum, not so foul as the first, which is removed as before. He then adds a fresh quantity of spice, but less than the former, and repeats this operation till the sugar casts up a clean milky froth, which indicates that the impurity is wholly extracted. The liquor is also sometimes examined with a bright silver or metal spoon, that any remaining foulness may be discovered. In the making of double loaves, powder loaves, or very fine single loaves, it is usual to heighten the natural colour of the sugar by the addition of a little blue. For this purpose, when the pans are almost clear, the quantity of about six pennyweights troy of the finest indigo, finely powdered, and filtered through a piece of woollen or blanketing in a bason of fresh water, and well stirred together in a bason, is thrown into each pan. The sugar being once raised in the pan after this infusion, the grosser particles of the colour are taken off in the last scum, and the remainder is incorporated with the sugar in the pan.

The panman having brought the sugar to the cleanest state, prepares to skip it off, or to shift it from one vessel to another; this is done by means of a wooden gutter laid along the parts, and opening into the clarifying cistern. Over this cistern upon large iron bars is fixed an oblong basket, about sixteen inches deep, in which a large thick blanket is fastened: and through this blanket and basket the sugar liquid passes out of the gutter; and to the mass a quantity of syrup is usually added. Having measured the quantity of liquid in the cistern with a rod graduated by inches, the panman pumps back into the pans either the sixth or ninth part of the whole, as he is directed by the supervisor or boiler; and the pans are all supplied together by means of a trough. When this is done, the fire is stirred up to a considerable degree of fierceness; and then commences a new operation, *viz.* evaporation. In this part of the process (the day's work being divided into three fillings), the panman pumps into the pan one-ninth part of the quantity in the cistern, which in a few seconds begins to boil, and must be continued in a boiling state, but not with too intense a fire; and to prevent the sugar from boiling up to the surface of the pan, or from boiling over, he casts a small quantity (*viz.* a piece as large as a nutmeg or walnut, as the case may require) of butter or grease into the boiling liquor. Here it is to be observed that sugar should boil low in the pan, and yet not too flat like water, for by rising hollow from the bottom, the necessary evaporation is retarded, and the sugar is exposed to the action of the fire for a longer time than it ought to be. In a space of time from twelve to thirty minutes, the evaporation will have produced its effect, and the sugar acquired the requisite degree of viscousness. This state will be indicated by various circumstances; as the bubbles dragging heavily over the surface of the boiling mass, and by the clammy liquid falling in ropes from the proof-stick: but principally by that test which is called the proof. For this purpose the boiler draws the stick out of the boiling liquid with his right hand, and placing his left thumb upon the sugar, draws it across the stick, carrying away upon the end of his thumb as much of the sugar as will hang upon it; he then, by means of a candle placed in a black box called the proof-box, and by repeated trials (drawing the sugar to a thread between his thumb and fore-finger) determines when the evaporation is complete; and when this is decided, the fire is smothered, and nearly quenched. The hot sugar liquor is then removed by means of basons out of the pans into coolers, two or three gallons being left in each pan, to prevent the bottom from being scorched; and the pans are again supplied with a quantity of liquor for the next evaporation. The liquor in the coolers is gently stirred, to prevent a crust from forming on its surface.

The next operation in refining is conducted in that part of the ground-floor of a sugar house, which is denominated the *fill-house*, because all the upper floors of the house are to be filled from this; and this operation consists in filling the moulds with the three skippings contained in the coolers. The moulds, in the form of inverted cones, previously prepared by soaking and washing them, and stopping their apertures with wet linen rags, are placed side by side, and in rows two or three deep; their number is to suffice for the quantity of liquor in the coolers, which is estimated by the number of basons which were skipped off from the pans; and they are propped up by other moulds (commonly such as are broken) placed with the broad end downwards, in front of the outward rank, by way of abutment; these are called *stayers*. The sugar being previously stirred in the coolers in order thoroughly to mix, each skipping is ladled out of the coolers in succession, and not all at once, (unless the fillings are small, in loaves, and always in lumps,) into basons conveniently situated; and these are carrie into the fill house, where as much of the sugar is poured into each mould as will fill about one third of its capacity; the same quantity is again poured into each; and at the third time they are filled to the brim.

The moulds being filled, the next operation, which is that of stirring the sugar in them, is called *hauling*, and is designed to prevent an adhesion to the mould, and to lay the grain of the mass even and regular through all its parts. In this business each man takes a tool made of wainscot, called a knife, and in size proportioned to that of the mould to be stirred; with this tool, keeping his hand over the centre of the mould, he scrapes the sugar from its sides by successive strokes downwards, carried all round; and when two revolutions are performed, the sugar is allowed to rest some minutes, until it has acquired some firmness. The moulds being stirred round three or four times, according to the direction of the boiler, are no more disturbed till they are pulled up.—The process already described relates to sugar *once refined*, called single loaves: double loaves are usually cleared with the whites of eggs instead of spice, (two hundred of which are necessary to each pan,) and with fresh water instead of lime water. With respect to the proof, one rule only can be laid down, *viz.* the sugar must be boiled higher as the moulds which contain it are enlarged.

SUGAR *of Roses*, is white sugar clarified, and boiled into the consistence of rose water. When thus prepared, it is formed into small lozenges, and sometimes into grains about the size of peas, by keeping it stirred until cold and dry. It is thought serviceable to soften and allay acrimonies, &c. of the breast.

SUGAR *Spirit*. This is a name given by distillers to a spirit made in England, Holland, and many other places, from the scum, washings, dross, and waste of a sugar-refining house. It is prepared in the same manner with that from malt and molasses, and is frequently used to adulterate brandy, rum, &c.

SUGAR OF LEAD. Acetate of lead.

SUICIDE, voluntary self-murder; the definitions of which, under all the circumstances that may occur, their various connexions and consequences, involve many curious, paradoxical, and perplexing questions.

SUIT, in Law, is used in different senses, as, 1. Suit personal. 2. Suit of court, or suit service, is an attendance that tenants owe to the court of their lord. 3. Suit covenant, is where the ancestor hath covenanted with another to sue to his court. 4. Suit custom, when a man and his ancestors have been seized, time out of mind, of his suit. 5. Suit real, or regal, when men come to the sheriff's torn or leet. 6. Suit signifies the following one in chase, as fresh suit. 7. It signifies a petition made to the king or any great person.

SUKOTYRO, a genus of quadrupeds, of the order bruta; generic character, born on each side near the eyes.

SULPHATES. Definite compounds of sulphuric acid with the salifiable bases.

SULPHITES. Definite compounds of sulphurous acids with their bases.

SULPHUR, is a well-known substance, sold in the form of a powder, or in solid pieces, when it is called brimstone. It is found in the neighbourhood of volcanoes: in the tract of land between Naples and the ancient Baiæ, called Solfaterra, the smoking plains, the remnant of a half-extinguished volcano, it is found in great abundance. Sulphur is brought in large quantities to this country from Mount Etna in Sicily, but is to be found in greater or less quantities near all volcanoes, of which the number throughout the world is very great. Sulphur is often found in coal mines, and indeed the common coal in our fires more or less contains this mineral. It is often found combined with iron, copper, and other metals, when it is called pyrites.

SULPHURETS, are combinations of alkalies, earths, or metals, with sulphur; hence a substance is said to be "sulphuretted," when it is combined with sulphur.

SULPHURIC ACID, is generally procured by burning a mixture of sulphur and nitre in chambers lined with lead. Sulphuric acid is a liquid somewhat of an oily consistence, transparent and colourless as water, without any smell, and of a very strong acid taste. When applied to animal or vegetable substances, it very soon destroys their texture.—Sulphuric acid may be procured by the following process; put into a glass retort two parts of sulphuric acid and one part of mercury, and apply the heat of a lamp; the mixture effervesces, and a gas issues from the beak of the retort, and may be received in glass jars filled with mercury, and standing in a mercurial trough. This gas is sulphuric acid.

SUM, in Mathematics, signifies the quantity that arises from the addition of two or more magnitudes, numbers, or quantities together.

SUMACH. Common sumach (rhus coriaria) is a shrub that grows naturally in Syria, Palestine, Spain, and Portugal. In the two last it is cultivated with great care. Its shoots are cut down every year quite to the root, and after being dried, they are reduced to a powder by a mill, and thus prepared for the purpose of dyeing and tanning.

SUMMONS, in Law, the citing or calling a person into any court, to answer a complaint, or to give evidence in cases that may require his testimony.

SUN. *See* ASTRONOMY.

SUNDAY, the first day of the week, and thus called by our idolatrous ancestors, because on this day the sun was worshipped. It is now more properly called the Lord's day, as commemorating the resurrection of our Lord; or Sabbath Day, being substituted under the gospel dispensation for the seventh day that was held sacred under the law.

SUPERCARGO, a person employed by merchants to go a voyage, and oversee their cargo or lading, and dispose of it to the best advantage.

SUPERFICIES, in Geometry, magnitude considered as having two dimensions, or an extension in length and breadth, but as being destitute of thickness or depth.

SUPERFINE, in the Manufactories, a word used to express the superlative fineness of a stuff. The term applies both to the materials and texture. Among gold and silver wire drawers, that is said to be superfine which is reduced to a hair-like size.

SUPERLATIVE, in Grammar, an inflexion of an adjective, denoting the highest or lowest degree of the quality the word was intended to express. In English, the superlative is gene.

rally formed by the addition of *est*, as wis*est*, poor*est*, black*est*, &c. When the word has more than two syllables in its positive state, the superlative is expressed by the prefixing of *most*, as *most* honourable, *most* tremendous.

SUPERNUMERARY, something over and above a fixed number. In several of the offices are supernumerary clerks, to be ready on extraordinary occasions. There are also supernumerary surveyors of the excise, to be ready to supply vacancies when they fall; these have but half-pay.

SUPERSEDEAS, a writ that lies in a great many cases, and signifies, in general, a command to stay proceedings, on good cause shewn, which ought otherwise to proceed. By a supersedeas, the doing of a thing which might otherwise have been lawfully done, is prevented; or, a thing that has been done, is, notwithstanding it was done in a due course of law, thereby made void. A supersedeas is either expressed or implied; an express supersedeas is sometimes by writ, sometimes without writ; where it is by writ, some person to whom the writ is directed, is thereby commanded to forbear the doing something therein mentioned; or if the thing has been already done, to revoke, as that can be done, the act. A person can be superseded out of prison, when, by the practice of the court, the plaintiff has omitted to proceed in due time against him.

SUPPLEMENT OF AN ARC, in Geometry, is the number of degrees that it wants of being an entire semicircle: as complement signifies what an arc wants of being a quadrant. In Literature, supplement is an appendage to a book, which supplies what was deficient in it.

SUPPLICAVIT, in Law, a writ issuing out of the court of King's Bench, or Chancery, for taking surety of the peace, when one is in danger of being hurt in his body by another.

SUPPORTERS, in Heraldry, figures standing on the scroll, and placed by the side of the escutcheon, and seeming to support or hold up the same. They are sometimes human figures, and at other times animals, and creatures of the imagination.

SUPPURATION, in Surgery, denotes the process by which purulent matter is formed in cases of abscesses, ulcers, &c.

SUPPURATIVES, are medicines that ripen and promote suppuration.

SUPREMACY, in English polity, is the sovereignty of the king over the church as well as the state of which he is the established head. Among the Roman Catholics, this supremacy in all ecclesiastical matters is lodged in the pope.

SURA, the name of a liquor in the East Indies, made of the juice that is extracted from the cocoa-tree. It is, however, not held in very high estimation.

SURCINGLE, a girdle with which the clergy of the church tie their cassocks. It is also a girth that comes over the saddle, and binds it firmly to the horse.

SURD, in Arithmetic and Algebra, denotes any number or quantity that is incommensurable to unity, otherwise called an irrational number or quantity.

SURETY, in Law, generally signifies the same with bail.

SURETY *of the Peace*. A justice of the peace may, according to his discretion, bind all those to keep the peace, who in his presence shall make any affray, or shall threaten to kill or beat any person, or shall contend together in hot words; and all those who shall go about with unlawful weapons or attendance to the terror of the people; and all such person as shall be known by him to be common barrators; and all who shall be brought before him by a constable for a breach of the peace in the presence of such constable; and all such persons, who having been before bound to keep the peace, shall be convicted of having forfeited their recognizance. Lamb. 77.

SURETY *of the good behaviour*, includes the peace, and he that is bound to the good behaviour, is therein also bound to the peace; and yet a man may be compelled to find securities for the good behaviour and the peace.

SURF, the swell of the sea, which breaks upon the shore, or any rock lying near the surface, which renders such places dangerous.

SURFEIT, an indisposition occasioned by eating or drinking to excess, or overcharging the stomach. It is usually attended with eruptions, and sometimes with fever

SURGERY, is the art of curing or alleviating diseases by local and external applications, manual or instrumental. As a science, it may be defined, that department of maladies thus susceptible of alleviation or cure.

SURNAME, a name added to the proper or baptismal name, to denominate the person of such a family. These hereditary names were first introduced by the Romans, on account of their league with the Sabines.

SURPLICE, the habit of the officiating clergy in the church of England.

SUR-REBUTTER, a second rebutter.

SUR-REJOINDER. As a rejoinder is the defendant's answer to the replication of the plaintiff, so a sur-rejoinder is the plaintiff's answer to the defendant's rejoinder.

SURRENDER, a deed or instrument testifying that the particular tenant of lands or tenements for life or years, does sufficiently consent and agree, that he who has the next or immediate remainder or reversion thereof, shall also have the present estate of the same in possession; and that he yields and gives up the same to him; for every surrenderer ought forthwith to give possession of the things surrendered.

SURROGATE, one who is substituted or appointed in the room of another; as the bishop or chancellor's surrogate.

SURSOLID, in Arithmetic, the fifth power of a number, or the fourth multiplication of any number considered as a root.

SURVEY, in Law, the ascertaining of the boundaries and royalties of a manor, or estate in lands, and also of the tenure of the respective tenants, and the rent and value of the estate.

SURVEYORS OF THE NAVY, two officers who sit at the navy board, being invested with the charge of building and repairing his majesty's ships at the different dock-yards of the kingdom; for which purpose they are trained to the theory and practice of ship-building.

SURVIVOR, in Law, signifies the longer liver of two joint tenants, or any two persons joined in the right of any thing.

SURVIVORSHIP. Payments which are not to be made till some future period, are termed *reversions*, to distinguish them from immediate payments. These being founded on contingencies, form a most intricate subject of calculation. Survivorship belongs only to those who survive other individuals, on the probable extent of whose lives the calculations are made, and the probable longevity of theirs who survive.

SUS, the *Hog*, in Natural History, a genus of mammalia, of the order belluæ. These animals are allied by their teeth to the carnivorous quadrupeds, and by their cloven feet to the ruminating ones. They feed almost indifferently upon animal and vegetable substances, devouring with avidity what is most nauseous and disgusting. They use their snout in digging up the ground in quest of roots, are fond of rolling and wallowing in mud, and distinguished by extreme fecundity. There are six species, of which the following is the most important.—The common hog. All the varieties of this animal originate in the wild boar, which is found in most of the temperate regions of Europe and Asia. It is smaller than the domesticated animal, and uniformly of a dark gray colour, approaching to black. It is armed with formidable tusks, sometimes ten inches, or even more, in length; those in the under jaw curving inwards, and capable, from their size, strength, and sharpness, of inflicting the most dreadful wounds. Before these animals attain their third year, they are gregarious, and, particularly when danger is at hand, they muster in numerous parties, and with great promptitude, at the signal of alarm. Uniting thus, they present so formidable an array, as speedily to disperse the enemy; few creatures, or none, daring to commence an attack against such a combination of strength and valour as they exhibit. When the wild boar is complete in growth, he depends upon his solitary exertions for his protection, is seldom seen in society, ranging the forests alone; rarely commencing an attack, as his food consists almost solely of roots and vegetables, but repelling one with all the fierceness of courage, and all the resentment of retaliation.—The babyroussa, is remarkable for the form and situation of the upper tusks, which are placed externally, and turn upwards in a curve towards the forehead. It abounds in the Indian islands, lives solely on vegetables, and rests itself, in sleep, by hooking its upper tusks round the branch of a tree. It can swim with rapidity, and is valued for food.—The Mexican hog, or pecari, is the only animal of the genus native of America, where it is gregarious, fierce, and dangerous, and is occasionally seen in herds of several hundreds. It feeds on fruits and roots, and also on serpents, lizards, and toads, and will attack and devour the rattlesnake, we are told, without the slightest injury.

**SUSPENSION**, or Points of Suspension, in Mechanics, are those points in the axis or beam of a balance, wherein the weights are applied, or from which they are suspended.

Suspension *of Arms*, in War, a short truce agreed on by both armies, in order to bury their dead, wait for fresh instructions, or the like.

**SUTTEE**, the self-immolation of a widow on the funeral pile of her deceased husband. This horrid practice still prevails in many parts of India, even in those that are under the immediate government of the English.

**SWAB**, a sort of mop, formed of a large bunch of old rope-yarns, and used to clean the decks and cabins of a ship. *Hand-Swab*, a smaller kind, used for wiping dry the stern-sheets of a boat, washing of plates and dishes, &c.

**SWABBER**, a man appointed to use the swabs in drying up the decks. He is sometimes called ship's swabber, but more commonly captain's swabber.

**SWALLOW**. *See* Hirundo.

**SWAN**, in Ornithology, a species of the anas or duck kind, of which there are two sorts, the wild and the tame. The tame swan is the largest of the English birds.

**SWARD**, in Agriculture, the green or grassy surface of the ground.

**SWARD-CUTTER**, a kind of plough invented by Mr. Sandiland, for the purpose of preparing old grass grounds for future purposes. This instrument is described at large in the sixth volume of the Bath papers.

**SWARM**. *See* Bees.

**SWATH**, a term denoting the ridge or line of newly mown grass or corn, as laid by the mowers.

Swath-*Bulk*, is the ridge of a stubble laid between two swaths in mowing.

**SWEARING**, an offence punishable by several statutes; thus, stat. 6 and 7 Will. III. cap. 11. ordains, that if any person shall profanely swear, if he is a labourer, servant, or common soldier, he shall forfeit 1*s*. to the poor, for the first offence, 2*s*. for the second, &c.; and any person not a servant, &c. forfeit 2*s*. for the first offence, 4*s*. for the second, 6*s*. for the third, &c. to be levied by distress of goods.

**SWEAT**, a sensible moisture issuing through the pores of men or animals, occasioned by too much heat, exercise, or weakness, or through the action of medicines called sudorifics.

**SWEATH**. *See* Swath.

**SWEATINGHOUSE**. The natives of North America, when we first settled among them, had a great many houses to sweat in, it being their general remedy for diseases, of whatever kind; but at present they are less used among them. The cave, or sweating house, is usually eight feet in diameter, and four feet high, the roof being supported by sticks or boards. They usually dig these caves in the side of a hill, and as near as can be to some river or pond. The entrance into the cave is small, and when any person is sweating in it, the door is covered with a blanket or skin. Near the cave they usually make a large fire, and heat in this a quantity of stones, perhaps five hundred weight; these they roll up into the cave, and pile up in a heap in the middle. When this is done, the Indians go in naked, as many as please, and sit round the heap of stones; and as soon as they begin to grow faint, which is usually in a quarter of an hour, they come out and plunge themselves all over in the water, remaining in it a minute or two; and repeating this a second time, they dress themselves, and go about their business. This has been for many ages used among them with success, in cases of colds, surfeits, sciaticas, and pains fixed in their limbs; and the English have often used the same means, and found relief by it. It is practised equally at all times of the year, and the Indians do it not only in sickness, but by way of refreshment after long journeys, and other fatigues, and to strengthen themselves for any expeditions.

Sweating-*Sickness*, a malignant disease which prevailed in England about the conclusion of the fifteenth and beginning of the sixteenth centuries, through which many thousands died.

**SWEDENBORGIANS**, a sect of mystics, so called from the ingenious and learned, though eccentric, Emanuel Swedenborg, a Swedish nobleman.

**SWEDISH TURNIP**, the name of a hard sort of turnip originally imported from Sweden, of which there are two sorts, the yellow and the white, but the former is deemed the more valuable. An instrument called the *Swedish Turnip Cutter*, for slicing these roots with great expedition, may be had of every farming-implement maker.

**SWEEPERS**, persons appointed (sometimes by way of punishment) to sweep the decks occasionally with brooms. *Captain Sweeper*, a man who has command over the preceding gang. *Sweeper of the Sky*, a name given by sailors to the N. W. winds of America.

**SWEEPING**, the act of dragging the bight, or loose part of a small rope, along the surface of the ground, in a harbour or road, in order to hook and recover some anchor, wreck, or other material, sunk at the bottom. It is performed by fastening the two ends of the rope to the sides of two boats, abreast of each other, at some distance. To the middle of the rope is suspended a weight, to sink it to the ground, so that as the boats advance by rowing ahead, the rope drags along the bottom, in order to hook any anchor, &c. for which they are searching

**SWEEPS**, large oars used on board ships of war in a calm, either to assist the rudder in turning them round, or to increase the ship's velocity in a chase. *Sweep of the Tiller*, the circular frame on which the tiller traverses, in large ships.

**SWEETBRIAR**, a shrubby plant of the briar kind, frequently cultivated in gardens for its fragrant and delightful smell.

**SWELL**, generally denotes a heavy and continued agitation of the waves, rolling in any particular direction. It is, however, more particularly applied to the fluctuating motion of the sea which remains after a storm, as also to that which breaks on the sea-shore, &c.

**SWIFTER**, a rope used to confine the bars of the capstan in their sockets, while the men are turning it round; for which purpose it is passed through holes in the extremities of the bars, so as to attach them firmly to each other like the felloes of a wheel, which operation is called swifting. See the article Capstan.

Swifter, is also a strong rope, sometimes used to encircle a boat lengthwise, as well to strengthen as to defend her sides from the impression of other boats which may run against her. It is usually fixed about nine inches below the boat's gunwale or upper edge. *Swifters*, are likewise two shrouds, fixed on the starboard and larboard sides of the lower masts, above all the other shrouds, as an additional security to the masts, and are never confined, like them, to the catharpings.

**SWIMMING**, the act of sustaining the body in water, and of moving in it; in which action the air-bladder and fins of fishes bear each a considerable part. So far as this exercise applies to man, it may be considered as highly useful, since it contributes to the development of the muscular powers, to the increase of strength, and the preservation of health. If we consider swimming in regard to cleanliness, it possesses the advantages of a cold bath, so frequently recommended as a most useful remedy to cleanse, fortify, and strengthen the body;—if we regard it as a means of preservation, we must acknowledge, that of all exercises there are none which give to us more confidence and more courage, under perilous circumstances: added to which is the high gratification we may procure to ourselves, from being the instrument of snatching a fellow creature, perhaps a friend, from a watery grave. It must not, however, be forgotten, that we can but have little pleasure and no safety in the water, as indifferent swimmers. Experience proves to us that more fatal accidents happen to those who swim imperfectly, than to such as cannot swim at all, the latter having no temptation to expose themselves to danger.

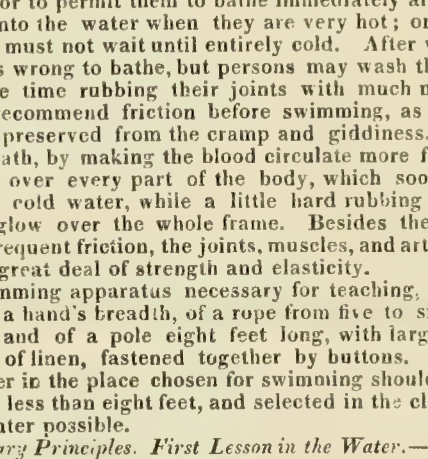
With many who are unacquainted with the art, and feel an instinctive repugnance to it, an opinion prevails that the danger is too great to be encountered, and the difficulties too formidable to be surmounted. These notions are entirely founded on mistake. In cases where the corporeal qualifications may not be great for swimming, yet if a person persevere in his efforts, he will become an excellent swimmer in a very short time, even with a feeble constitution or bodily defects. It is also an error to believe, that grown-up men cannot learn to swim;

experience daily teaches us the contrary; and the great number of soldiers and private individuals who are taught swimming in the different European establishments, proves clearly to us that a person can learn at any period of life, even so as to become very expert in the art. All swimmers being of opinion, that it is only the position of the body and the regular movements of the limbs which give them the power of swimming for a length of time and without much fatigue, it is evident that children may be taught the elementary principles of natation without having recourse to water, or to a number of instruments, which only augment the difficulty.

The summer being very short, and often cold, in northern climates, and even in more temperate ones, young persons have not the same facility of bathing every day, and at any hour, as those who live in more southern countries; added to which, the water of the rivers in these countries is always cold, which prevents their remaining in the bath as long as they could wish. This circumstance is a great obstacle to the progress which they might make in swimming, and frequently disgusts them with this exercise. As to the precautions, we request the instructors not to be too rough with their pupils, and, above all, never to force them to leap into the water, without their being able to swim, nor to permit them to bathe immediately after dinner, nor to go into the water when they are very hot; on the other hand, they must not wait until entirely cold. After violent exercises it is wrong to bathe, but persons may wash themselves, at the same time rubbing their joints with much more force. We also recommend friction before swimming, as the surest way to be preserved from the cramp and giddiness. Friction after the bath, by making the blood circulate more freely, distributes it over every part of the body, which soon gets benumbed in cold water, while a little hard rubbing creates an agreeable glow over the whole frame. Besides these advantages, by frequent friction, the joints, muscles, and articulations, acquire a great deal of strength and elasticity.

The swimming apparatus necessary for teaching, consists of a girdle of a hand's breadth, of a rope from five to six fathoms in length, and of a pole eight feet long, with large drawers and jacket of linen, fastened together by buttons. The depth of the water in the place chosen for swimming should, if possible, be not less than eight feet, and selected in the clearest and calmest water possible.

*Elementary Principles. First Lesson in the Water.*—The swimming girdle is placed round the pupil's breast in such a manner, that its upper edge touches the pap of the breast, (see the figure.) The pupil is then conducted to the water, and recommended to go gently into it. As soon as the pupil is in the water, in order to inspire him with confidence, the teacher winds the end of the rope, which he holds in his hand, round the pole, and leaning the pole on the rail, he swings the pupil into the water, in such a way, that the latter appears to repose on its surface. The pupil is not placed in a perfectly horizontal position, the head is plunged up to the mouth, the arms are stiffly stretched forwards, so that the palms of the hands touch each other; the legs are also stiffly stretched out, and the heels are kept together, but the toes are turned to the outside and contracted, as in the annexed figure, this is called ranging. In this position the pupil must remain for some time, till he feels it becomes easy to him. When this is well known, the pupil proceeds to the movements. That of the feet is taught first, during which the arms are to remain immoveably stretched out. The motion of the legs is divided into three parts: first, they are slowly drawn under the body, and at the same time the knees separate to the greatest possible distance; the spine is bent downwards, and the toe kept outwards. Secondly, the legs are stiffly stretched out with a moderate degree of quickness, while the heels are separated, and the legs describe the widest possible angle, the toes contracted and kept outwards. Thirdly, the legs, with the knees held stiffly, are quickly brought together, and thus the original position is again obtained. The main advantage of swimming lies in this third part of the motion. The pupil is now loosened from the pole, but remains attached to the rope. The teacher then takes the loose end of the rope, and causes him to take a running leap into the water, to rise without help to the surface, and thus to commence swimming alone. During the leap, the legs are to be kept together, and the arms close to the body. Above all, the pupil should be enjoined, when he rises to the surface, not to open his mouth immediately, but previously to repel the water from his nose to prevent head-ache. When necessity compels us to jump from a certain height into shallow water, in a place with which we are not acquainted, or in a muddy river, it is of great importance to place the feet or hands foremost, observing to extend the diagonal line, which the body is to describe as much as possible. With some practice in this exercise, one may jump from the height of twenty feet, in water only five feet deep, without hurting himself. In a regular swimming school, to improve a great number of scholars in a very short time, one ought to fix in the centre of it, (in a large barge for instance,) a mast, upon the top of which ten or more ropes could be fixed. The pupil tied at the end describes a large circle, swimming round the barge, and can stop when he likes. This is one of the most amusing and improving exercises in the art.



*Diving.* The exercise of diving must begin by remaining under water without motion. The most pleasant manner for the diver is, to let himself sink gently into the water, by means of a pole or rope. The breath must be drawn in slowly, and expelled by degrees, when the heart begins to beat very strongly. If the pupil has practised himself in this for some time, he may then begin to swim under water and to dive to the bottom. In swimming under water, he may either move in the usual way, or keep his hands stretched before him, which will enable him to cut the water more easily, and greatly relieve the breast. If he wishes to dive to the bottom, he must turn the palms of the hands upwards, striking with them repeatedly and rapidly, whilst the feet are reposing; and when he has obtained a perpendicular position, he should stretch out his hands like feelers, and make the usual movement with his feet; then he will descend with great rapidity to the bottom. It is well to accustom the eyes to open themselves under the water, at least in those beds of water which admit the light, as it will enable us to ascertain the depth of the water we are in.

*Saving from Danger.*—It is necessary for a swimmer to know how to act in rescuing a drowning person without himself becoming the victim, as so often happens; we therefore lay down the following rules:—The swimmer must avoid approaching the drowning person in front, in order that he may not be grasped by him; for wherever a drowning person seizes, he holds with convulsive force, and it is no easy matter to get disentangled from his grasp; therefore he ought to seize him from behind, and let him loose immediately the other turns towards him; his best way is, either to impel him before to the shore, or to draw him behind; if the space to be passed be too great, he should seize him by the foot and drag him, turning him on his back. If the drowning person has seized him, there is no other resource for the swimmer than to drop at once to the bottom of the water, and there to wrestle with his antagonist; the drowning man endeavours, by a kind of instinct, to regain the surface, and when drawn down to the bottom, he usually quits his prey, particularly if the diver attacks him there with all his power. For two swimmers, the labour is easier, because they can mutually relieve each other.

SWINE. *See* SUS.

SWIVEL, a small piece of artillery, carrying a shot of half a pound, and fixed in a socket on the top of a ship's side, stern, or bow, and also in the tops; the trunnions of this piece are contained in a sort of iron crotch, whose lower end terminates in a cylindrical pivot resting in the socket, so as to support the weight of the cannon. By means of this swivel (which gives name to the piece of artillery) and an iron handle on its cascabel, the gun may be directed by hand to any object. *Swivel* is also a strong link of iron used in mooring-chains, &c. which permits the bridles to be turned repeatedly round, as occasion requires.

SWORD. A weapon used either in cutting or thrusting; the usual weapon of fights hand to hand. It also signifies figuratively, destruction by war; as, fire and sword.

SYCAMORE, (*Acer Pseudoplatanus*,) the *Plane Tree* of Scotland, and *Ficus Sycamorus*, the *Egyptian Fig-tree*; both grow to a large size. The wood of the former is soft, white, and chiefly valued by turners.

SYLLABUB, a kind of compound drink, chiefly in demand during summer. It is ordinarily made of white wine and sugar, into which some new milk is thrown by a syringe. The ingredients, however, vary in different hands, as also the proportions of the articles used.

SYLLOGISM, in Logic, an argument or term of reasoning, consisting of three propositions; the two first of which are called premises, and the last the conclusion: as, Every creature possessed of reason and liberty, is accountable for his actions. Man is a creature possessed of reason and liberty; therefore man is accountable for his actions.

SYMBOL, a sign or representation of any moral subject by the images or properties of things natural. Thus, courage finds its symbol in the lion, parental affection in the pelican, &c. Among Christians, bread and wine are symbols of the body and blood of Christ.

SYMPATHY, an agreement of affections and inclinations, or a conformity of humours, temperaments, and natural qualities, which makes two persons pleased and delighted with each other. The various opinions that have been entertained respecting the power of sympathy, have led to many curious and romantic speculations.

SYMPHONY, in Music, properly denotes a consonance or concert of several sounds agreeable to the ear, whether vocal or instrumental, called also harmony.

SYMPTOM, in Medicine, denotes any change in the body or its functions, (perceptible either to an observer, or to the patient himself,) which indicates disease.

SYNAGOGUE, literally imports an assembly or congregation; but it is now restricted to a particular assembly of the Jews, met to perform the offices of their religious worship.

SYNCHRONISM, the happening of several things or events together, at or in the same time.

SYNCOPE, in Physiology, fainting.

SYNECDOCHE, in Rhetoric, a figure, in which the whole of a thing is put for a part of it only, or a part for a whole. This figure is of very considerable latitude; and is used, 1st, when the genus is put for the species; 2dly, when the species is put for the genus; 3dly, when the essential whole is put for one of its parts; 4thly, when the matter or form is put for the whole being; 5thly, the whole for a part; or lastly, the part for the whole.

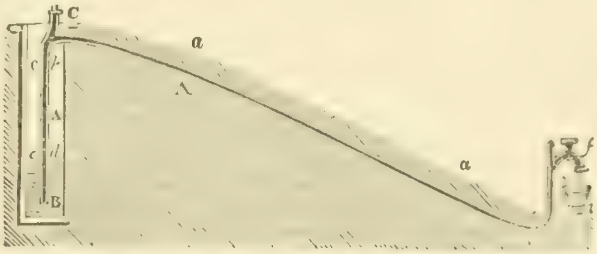
SYNOD, in church history, is a council or meeting of ecclesiastics, to consult on matters of a religious nature.

SYNTAX, in Grammar, the proper construction or due disposition of the words of a language into sentences.

SYNTHESIS, in Logic, a method of pursuing truth by reasons drawn from pre-established principles, or propositions already proved, and thus proceeding by a regular chain, until we reach the conclusion.

SYPHON, *On the more extensive Employment of the.* The syphon, one of the most simple but at the same time interesting of hydraulic instruments, may be very considerably extended. We shall at present content ourselves with pointing out the advantage with which it may be applied to the conveyance of water to a distance over eminences, from a spring, well, &c. properly situated for the purpose. The usual methods of conveying water in such situations are either by cutting away the eminence to lay a pipe at a sufficient depth to obtain a fall, or by raising the water, by means of a pump, to a reservoir, and conveying it thence by a pipe to the situation required: both these methods we consider objectionable; the former, because of the great labour and expense attending the execution, besides the difficulty of getting to the pipe in case of a leak or stoppage; and the latter, on account of the original expense, the continual labour of pumping, liability of the pump to get out of repair, &c.

The syphon is liable to few or none of these objections; and the reason it has been so little employed is probably the difficulty or the expense of exhausting the air from out of the syphons on a large scale. To obviate this, may be adopted the following simple and easy method of setting any syphon to work, however large its dimensions, provided the perpendicular height of the shorter leg is not greater than the column of water capable of being raised by the pressure of the atmosphere. This method is not only simple, and easy to be repeated when necessary, but attended with so trifling an expense as must remo any objection on that score.



*a a a* represents the surface of the ground, *b c d e*, a well, the depth of which we will suppose to be seven yards, and the depth of water one yard; *f* the situation where the water is wanted, the distance of which from the well is immaterial. A A A, the syphon; at the extremity of the shorter leg B, which is immersed in the water, is a valve opening upwards, and at the other extremity is a cock, which may either be a common one, or one with a ball, &c, according to circumstances; at the crown of the syphon, a pipe C is soldered to the highest part of the bend, for the purpose of filling the syphon with water, and which must be done gradually, to admit the air to escape as the water descends. When the syphon is quite filled with the water, the top of the pipe C must be made perfectly air-tight, by means of a screw-cap, with a collar of leather, or, if on a large scale, by means of a flange, with screw bolts and nuts, &c. When this is done, turn the cock at *f*, and the water will commence and continue a rapid stream, as long as any remains in the well. Great care must of course be taken that the pipe composing the syphon is good, and perfectly air-tight.

SYRINGE, an instrument so constructed as to imbibe a quantity of any fluid, and to squirt or expel the same with violence. The uses to which the syringe has of late been applied, have rendered it so important, that for one invented by Mr. Read a patent has been obtained, and its vast utility renders it worthy of a particular description. In cases of swallowing poison, it has been so repeatedly and successfully tried, that no doubt can remain as to its intrinsic value. The apparatus consists of the pump, now generally known by the name of the "Stomach Pump," the œsophagus tube, three leathern tubes, and three ivory pipes, (which last, with the third leathern tube, is used only for enemas,) and a brass socket. The cylinder of the pump or syringe, (made in brass and in silver,) is about seven inches in length, and one inch in diameter, contracted at its apex into a small opening for receiving the extremity of an elastic tube, which is passed into the stomach. Within this opening is a chamber containing a spherical valve, which, by rising into the upper part of the chamber, where a vacuum is formed by elevating the piston, admits the fluid to pass freely into the syringe, but as soon as the piston is depressed, the contents of the syringe press the valve close upon the aperture, and prevent its escape through the opening by which it was received. To give exit to the contents of the syringe, a side branch is constructed, furnished with a valved chamber, similar to the one above described, but so placed as to act in direct opposition to it, so that when the syringe has been filled from the extremity, and pressure is made by depressing the piston, the fluid closes the lower valve, and opens the lateral one, and consequently escapes through the latter aperture. To facilitate the operation of the instrument, a small pipe communicates with the upper extremity of the syringe, which gives free ingress and egress to the atmosphere during the action of the piston, a circumstance essentially necessary in causing the instrument to work easily and perfectly. The operation of evacuating poison from the stomach, is represented in the annexed engraving. Figure A represents the operation of injecting fluids into the stomach, to dilute the poison previous to its extraction. This is effected in the following manner:—Screw the two first lengths of the leathern tube to the lateral branch of the syringe, and next the detached socket to the extremity of the former. The œsophagus tube is now to be passed through the mouth into the stomach, which being done, insert the brass joint at its extremity, into the socket at the end of the leathern tubes. The fluid to be injected, being put into a basin or other shallow vessel, the end of the syringe is immersed in it, and the piston being put into action, any quantity may be thrown into the stomach that shall be desired.

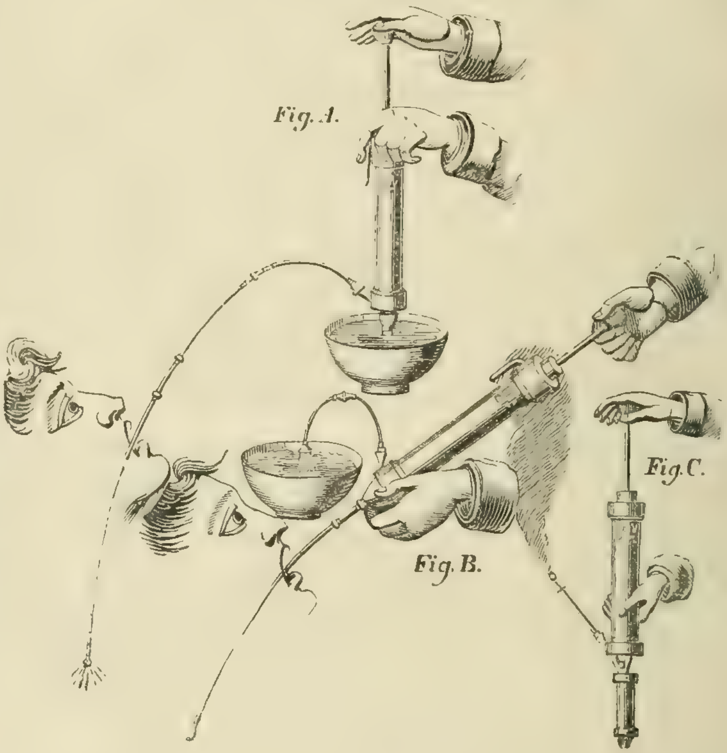
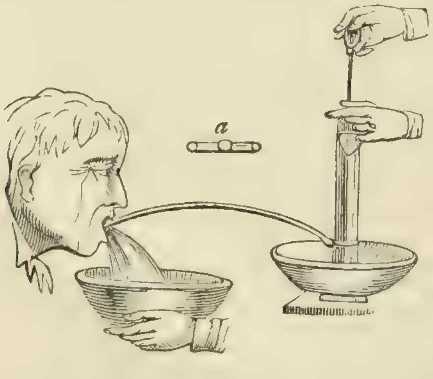


Fig. A.
Fig. C.
Fig. B.

*Emptying the Stomach.*—A sufficient quantity of fluid having been injected into the stomach by the above process, the enema tube is to be withdrawn from the œsophagus tube, (without removing the former from the syringe, or the latter from the stomach,) and the joint of the œsophagus tube inserted into the extremity of the syringe; let an assistant now hold a vessel to the end of the enema tube, and by working the piston, the contents of the stomach may speedily be pumped into it, as shewn in figure B of the drawing. By thus transferring the end of the œsophagus tube from one situation to the other, the two processes of washing and emptying the stomach, may be repeated as often as is judged necessary by the operator. Thus it is seen that the syringe is furnished with two valvular apertures, through one of which the contents of the stomach pass into the cylinder, and are then immediately forced through the other into the receiving vessel. This double operation is effected by repeated strokes of the piston, which slides so easily, that an infant may use it. The manner in which the syringe is held in the two separate operations, is very important. In the first, as is seen in the engraving, a perpendicular position is the most eligible; but in the second, the syringe must be held in an *inclined* position, at about an angle of 45°, with the lateral tube *upwards*. These positions preserve the valves upon their proper bearings, without which the instrument cannot act perfectly.

*A New Method of Operating with Read's Patent Syringe.*—An improved mode of removing poison from the stomach with this instrument was first adopted in St. Thomas's Hospital, and has since been performed successfully in a variety of cases, as represented in the following sketch. *a*, a guard, to be introduced between the teeth, for protecting the œsophagus tube from injury.

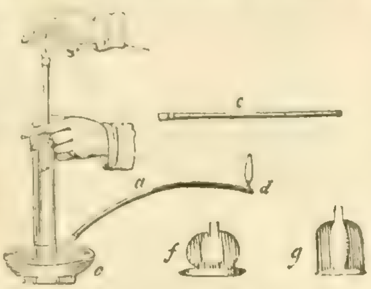


This is by far the quickest, easiest, and most simple mode of operating that has hitherto been devised, requiring no shifting of the apparatus, nor interruptions of the operation. It consists simply in filling the stomach, (according to the method of fig. A, in the preceding engraving,) until surcharged, or until it begins to react upon its contents, when the fluid regurgitates by the mouth. The pumping being now continued, the contents of the stomach are washed up, and forced, by the power of the pump, through the œsophagus (by the side of the tube) into a vessel held under the chin to receive it. The operation may be continued as long as the surgeon thinks proper, or until the fluid returns unchanged, which indicates the thoroughly cleansed state of the stomach. The operator may occasionally suspend the action for an instant, if necessary, to allow the patient to inspire. By this means the fluid may be injected in the quantity of three quarts a minute.—But it is not merely to the extracting of poisons from the stomach that the use of the patent syringe is confined, as may be gathered from the following particulars.

*Injecting the Bladder.*—In cases of retention of urine, it frequently happens, that in consequence of hæmorrhage and other causes, the catheter becomes so obstructed that the bladder cannot be emptied. It was suggested to Mr. Scott by Dr. Cloquet, a celebrated surgeon of Paris, to effect this purpose by fixing a pump to the catheter. The patent syringe performs this operation with extreme facility, and has been honoured with the entire approbation of Dr. Cloquet. For injecting the bladder, which is an operation every day becoming more frequent, it is of course equally eligible. For these purposes, Mr. Read has constructed elastic gum catheters, to be fixed to the extremity of the enema tube: see *e* in the following engraving.

As an apparatus for conveying nourishment into the stomach of persons afflicted with stricture of the œsophagus, and stimulating liquids in cases of suspended animation, the patent syringe is found to possess obvious advantages.

*Cupping and Drawing the Breasts.*—This pump is also capable of being adjusted to cupping-glasses, by which any degree of exhaustion can be made, that the operator desires; and in the same manner it may be rendered a very effectual instrument for drawing the breasts of puerperal females. Mr. Read has had glasses made for these uses, which may be obtained with the rest of the apparatus: see *f*, *g*, in the succeeding engraving.



*Tobacco Fumigation and Enema Injection.—Tobacco Fumigation.* Figure C in the first Plate, represents the syringe with a canister, for the purpose of injecting tobacco fumes into the intestines. It is used in the following manner: Unscrew the cap of the canister, and take out the perforated plunger; put in the tobacco (half an ounce, or an ounce) and replace the plunger lightly upon it; then put on the cap, and screw it to the end of the syringe; hold a lighted candle close under the bottom of the canister, and a stroke or two of the piston of the syringe will light the tobacco. The enema tubes being now fixed to the side branch, and the pipe introduced into the rectum, the tobacco-smoke is forced into the intestines as long as the syringe is worked in the usual manner.

*Operation of administering Enemas.*—We have lastly to speak of this syringe as an instrument for administering enemas, which was the original intention for which it was constructed, and in this point of view it is of the highest importance. On this subject Mr Read has been favoured with the following remarks from the pen of Mr. Scott, and we gladly avail ourselves of his permission to insert them.

"The objects of administering enemas are considered to be of three kinds: 1st, For softening and diluting retained fæces; 2ndly, For stimulating the bowels, and thus provoking evacuations; and, 3rdly, For producing mechanical distension. It must be obvious to every medical practitioner, how very inadequate the old apparatus of the pipe and bladder is to the completion of these objects; and thence it is that various instruments have been at different times devised, to remedy the deficiency; but ingenuity had been exercised in vain, and the profession were still in need of an instrument to effect these valuable ends, until the patent syringe supplied the desired means. It had hitherto been the custom of surgeons, in administering enemas, to throw up three-quarters of a pint, or a pint, of fluid; and a clyster, even in the severest cases, rarely exceeded the latter quantity. Now, by an attention to the anatomical structure of the lower intestines, it must be apparent that such a quantity would be incapable of effecting more than a mere solution of the feculent matter contained in the rectum, and of stimulating this bowel only; for the calibre of the rectum is so great, that, under ordinary circumstances, it can of itself contain a pint of fluid. Most commonly the cause of constipation exists in the colon; how then can the disease be relieved or removed by a clyster that is expended before it reaches this part of the canal? It will be urged, perhaps, that the superior bowels will be affected sympathetically, when the lower bowel is stimulated; but, granting this to be fact, how desirable is it to insure the good effects of an enema by administering a quantity sufficient to reach the offending part of the intestinal tube! But this could not be done by any of the existing instruments, as not one of them was of a size to contain a sufficient quantity of fluid; and, if they had been, it would have required a greater degree of power to force it into the bowels, than could have been conveniently or safely directed. I may, perhaps, be asked, why a large quantity could not be applied by recharging the instrument, or by discharging other instruments ready filled, and placed at hand for that purpose? I need not point out the fallacy of this argument to medical men, practically acquainted with the operation; for they are well aware of the difficulties which suspending the operation would present to the introduction of separate portions of fluid, as the *conatus ejiciendi* is generally so quickly excited, as to leave but a short interval between the injection and expulsion." An instrument was therefore wanted, that was capable of throwing up any quantity desired, in one continuous operation, and the patent syringe most completely effects this. Again, mechanical distension can only be effected by an instrument affording power with volume; an attention to hydraulic principles shews how both these are yielded by the syringe that Mr. Read has constructed. The bulk of the fluid contained in the instrument is so small, that the force necessary to propel it scarcely requires the efforts of an infant; but the effects of these efforts, multiplied by repetition, increase to an almost infinite ratio, and at length present an overwhelming force, capable of bearing down all opposition, and overcoming all natural restraints. To try the power of the syringe, Mr. Read fixed the injecting pipe firmly into the rectum of an animal that had been recently killed, and proceeded to pump into the bowels a large quantity of water, and he continued the operation with the same ease and freedom, until the intestinal canal, stretched beyond its tone, burst with the distending force. In corroboration of the good effects of this instrument in obstructions of the bowels, we shall take leave to extract the following remarks from some of the most respectable medical publications of the present time.

"Dr. Chisholm has related a case of obstinate constipation of the bowels, relieved by Read's Injecting Machine, after various other means had failed. The obstruction had existed three or four days before Dr. Chisholm saw the patient with Mr. Beet, surgeon, of Ashford. When seen by Dr. Chisholm, the patient's extremities were cold, and stercoraceous vomiting had come on. A tepid solution of yellow soap was prepared, and more than a wash-hand basin full was gradually but perseveringly thrown up by means of the instrument above mentioned, and prevented from returning by napkins pressed to the anus. The patient's belly now resembled a drum. When the injection was allowed to come away, the spectators had the gratification to find it mixed with fæces. Shortly after this, the patient passed flatus and stools, and all the bad symptoms quickly vanished. 'I have had many other causes,' says Dr. Chisholm, 'where Read's Machine was of infinite service, and I think every medical practitioner should have one of these instruments in his possession.'"—Med. Repository, No. 1, new Series, page 944.

The author of *The Village Doctor*, under the article Costiveness, (page 104,) makes the following remark: "But the use of clysters is in every way preferable to purgative medicines, and those who are costive should provide themselves with Read's Patent Syringe, and administer a pint of the domestic enema every day at a certain hour, until the bowels act without."

The following remarks are to be seen in Dr. Johnson's Quarterly Review: "For many months past we have been in the habit of employing Mr. Read's Patent Injecting Apparatus, which is so small as to be carried in the waistcoat pocket, and so powerful as to throw fluids to a great distance. The object of our present notice, however, is to inform our readers that Mr. Read has adapted to the instrument a flexible elastic tube, most admirably calculated for throwing fluids into the stomach, and then extracting them in cases of poisoning. We have attentively examined the instrument, and we know it is approved of by Sir A. Cooper, and some of the first surgeons of the Metropolis; we think it of so much importance, that we seriously recommend it to every private practitioner."—Vol. iv. No. 15, page 742, of the Medico-Chirurgical Review.

In treating upon iliac passion, an author, before mentioned, says, "A copious injection of six or eight quarts of warm water, or gruel, will be the most likely means of removing the obstruction, restoring the bowels to their proper situation, and of softening and bringing away those hardened motions, which accumulate in the bowels, and occasion the complaint. For this purpose (as well as for the injection of tobacco smoke,) Read's patent syringe is preferable to all other instruments, and should be in the possession of every family."—Scott's "Village Doctor," page 166.

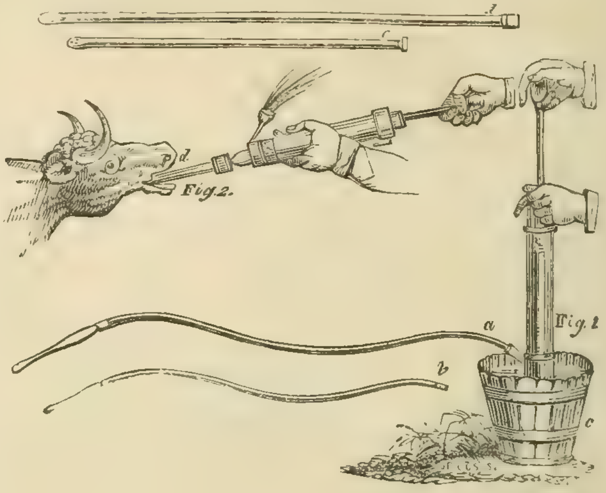
We are informed by some medical gentlemen who have used it, that in violent cases of menorrhagia, they have been able to check the disease more effectually by an alum injection thrown by the force which the patent syringe affords, than by any other means.

*Directions for Using the Enema Apparatus.*—We shall close our subject by the following explanation of the manner of using the enema apparatus:—Fix the enema tube to the lateral branch of the syringe, and put the fluid to be injected into a wash-hand basin, or other convenient vessel; the ivory pipe being inserted into the rectum, and the extremity of the syringe into the fluid, the pump may be worked, either by the patient or some other person; but the facility with which it can be accomplished by the former, by fixing the curved pipe to the tube, renders it truly valuable for domestic use.

The following extract of a letter, dated General Infirmary, Northampton, December 4, 1824, and addressed to Mr. Read, shews the practical utility of his invention:—"A boy, nine years of age, was discovered at eight o'clock in the morning of the 12th ult. in nearly a lifeless state. On investigation it was ascertained that he had taken, by mistake, a solution of opium three hours before. He was lying in a deep stupor, his respiration very slow, and accompanied with a convulsive catching; his feet, hands, and face livid, and no pulse to be felt at the wrist. He was immediately roused up, and violently shaken, when he uttered a few incoherent cries. A quart of warm water was instantly injected into the stomach by means of your syringe, and then withdrawn; the fluid was brown, and the smell of opium plainly perceptible. Another quantity of water was then thrown in, and withdrawn; it returned colourless, and without any smell.—The boy was now moved continually about for some time, and his senses gradually returned. As soon as he could swallow, he was made to drink two ounces of ipecacuanha wine, with a drachm of sulphate of zinc, dissolved in half a pint of warm water. This not operating, in twenty minutes a second dose was given as strong as the first, and in ten minutes afterwards the boy shewed a disposition to vomit: this was effectually excited by injecting a hand-basin full of warm water, by which I made sure that his stomach should be completely washed of any remains of the poison. After the vomiting was over, he was kept in motion three or four hours, taking at intervals a strong decoction of coffee: by the afternoon of the same day I had the pleasure of finding him perfectly well.—It is almost unnecessary to observe, that as the opium had been swallowed three hours, (and that too upon an empty stomach,) no emetic medicine would have operated until the poison was withdrawn, the fibres of the stomach being rendered perfectly inert by the stupefactive effect of the drug; indeed he had totally lost the power of swallowing; it is therefore pretty evident, that the boy's life would not have been saved, but for the very useful instrument of which you have the merit of being the inventor. I am, sir, with much respect, your obedient servant, CHARLES WITT, House Surgeon." "Approved, C. Bouverie, Chairman of the Committee."

SYRINGE, *applied to Veterinary Practice.*—"A righteous man regardeth the life of his beast." Proverbs, chap. xii. v. 10.—Fig. 1, *a*, enema tube for horses; *b*, ditto do. dogs; *c*, vessel containing the injecting fluid. Fig. 2, injecting apparatus for hoven or blown cattle; *d*, the œsophagus tube for bullocks; *e*, ditto do. sheep.

Animals, as well as man, are liable to accidents and disorders, that demand the aid of medical surgery; and among these, the occurrence of constipation and obstruction of the bowels, and of the fatal effects of excessive abdominal distension, from an undue quantity of improper food, frequently brings a most useful and highly valued animal into a situation of the utmost danger. Examples of the former are constantly experienced with horses and dogs. The former possesses a tendency to costiveness, from the dry nature of the food with which they are supplied, under the general routine practice of feeding; and they are rendered still more susceptible of this state, and consequently of obstruction and even inflammation, by protracted and heavy labour, and by neglect or improper management after severe exercise. It is also a well-ascertained fact, that the sports of the field induce a costive state of the bowels of dogs, that often reduce the animal's condition and health, and not unfrequently destroy his life. The attention of sportsmen and gentlemen cannot, therefore, be too seriously drawn to this subject; and we present to their consideration an instrument by which the lives of many valuable animals have been saved, when every other means had failed. By means of the apparatus represented by fig. 1, enemas may be easily administered either to horses or dogs: and the instrument is such as to admit of any quantity being injected that may be considered applicable to the size of the animal and to the nature of the case. The engraving, fig. 1, represents the action of the instrument; the tube being screwed to the side branch of the syringe, and the pipe introduced into the bowels, the extremity of the syringe is held in the fluid to be injected (which is put into a pail or other convenient vessel) and the piston being put into action, the clyster passes freely into the intestines. The facility afforded by this instrument, of throwing fluids into the bowels of animals, was demonstrated by an experiment performed at Charlton Mews, before Mr. Goodwin, his majesty's veterinary surgeon, in which Mr. Read injected a clyster of three gallons in two minutes.



The next consideration, as to the applicability of the instrument, is to the cases of hoven (or blown) cattle. The frequency of this occurrence to bullocks and sheep, from overgorging with potatoes, turnips, flax-seed, ground meal, green clover, or any moist or succulent food, is unfortunately well known to the agriculturist, and every person practically engaged in the breed and management of stock; and it has been often experienced, that the means generally resorted to in those cases are but too frequently ineffective. The failure may be accounted for by observing how inadequate either puncture in the loin, or the introduction of Monro's tube, is to the evacuation of the offending matter: if this were merely gas, either of the above means would probably liberate it; but it should be known that the stomach is filled by a fermenting pultaceous mixture of solids, fluids, and gas, that cannot be discharged in the manner of gas simply. The patent syringe, before described, is found to be as exactly applicable for this as for any other purpose; and Mr. Read has prepared tubes to be fixed to it, either for sheep or bullocks, see plate *d. e.* Fig. 2, shews the operation of extracting the contents of the stomach of a blown bullock; the tube is passed into the stomach, and the syringe being fixed to it, and put into action, the offending matter is discharged at the side opening.

*Horticultural and Domestic Uses of the Patent Syringe.* Numerous and important as the uses of the patent syringe are in animal application, its utility is capable of a still further extension. For watering pines and all other plants in conservatories and hot-houses, and for the destruction of insects upon trees in forcing-houses or on walls, it far exceeds the barrow-engine in the facility of its application. The Horticultural Society of London, to mark their approbation of it, honoured the patentee by conferring upon him their silver medal for the invention. It has of late been much used for washing the windows of houses and carriages, and is found to be a most effective apparatus for fumigating trees and hot-houses.

This instrument also, in case of need, is an excellent fire-engine, as from it portability it can be applied to the first breaking out of a fire, when no sort of assistance could be derived from the engines of the Insurance Companies, and its utilility in this way having been proved by actual experience, most of the Fire Offices have prepared themselves with it, and it is now very properly finding its way into private families, as a safeguard against the destructive and hazardous effects of fire.

Having thus described the uses of this simple but valuable invention, we close the subject, with the following statement of the whole expense of the apparatus:—Price of the enema apparatus £2. 12*s*. 6*d*. and with the tobacco canister, £3. 3*s*.—Price of the poison apparatus, £3. 10*s*.—The catheter 6*s*.—The nipple glass 6*s*.—and the cupping glasses 6*s*. each.

**SYRINGOTON**, the name of an instrument to lay open the fistula.

**SYRUP**, an agreeable liquor or composition, of a thick consistence, made of juices, tinctures, or waters, of fruits, flowers, or herbs, boiled up with sugar or honey, in order to preserve the compound from spoiling by fermentation, or otherwise. Syrups furnish an almost endless variety.

**SYSTEM**, in general denotes an assemblage or chain of principles and conclusion; or the whole of any doctrine, the several parts whereof are bound together, and depend on each other.

**SYTHE**, the subject of the Hainault sythe having excited considerable interest, we present our readers with an engraving, and an account of it extracted from the Farmer's Magazine of August, 1825. This instrument was brought under the notice of the Directors of the Highland Society of Scotland so far back as June, 1823. The summer general meeting passed over, and no funds could be voted to defray the necessary expense of trial that season; the directors could only recommend to the members and their friends, who might travel in Flanders during the then ensuing harvest, to obtain information respecting it on the spot; and, with a view to the ulterior proceedings contemplated, the deputy-secretary was directed to procure two of the sythes. Many of our readers must have heard of the trials made several years ago with the Hainault sythe on the farm of Mudiford, near Christchurch, belonging to Sir George H. Rose. This gentleman had employed a Flemish labourer, a prisoner of war, to teach his people the use of it; and some of them, it appears, had acquired great proficiency, and were able to instruct others. The first experiments were reported in the newspapers, and attracted a good deal of notice at the time; and yet it does not appear that this had the effect of introducing it into general use even in that neighbourhood. Whatever may have been the cause of this, it is certain, that its comparative merits were neither unknown nor unappreciated in other quarters. Mr. Warden, Sir George's bailiff, after this gentleman had let his farm, on being appointed to the embassy at Berlin, had instructed the reapers of Colonel Hughes, near St. Asaph, and those of 'Sir Watkin W. Wynne, at Wynnestay. It appears also, from recent information, that the Hainault sythe, if not in common use, is at least well known in different parts of Wales, as well as of England, and that it was tried some time back as far north as Aberdeenshire. The directors of the Highland Society were not ignorant of all this; but, knowing the difficulties which a new implement has to encounter before it can be subjected to a sufficient number of well-conducted experiments to have its merits decided on,—difficulties which could not fail to be increased by this being a foreign implement, and probably often used by unskilful hands,—they resolved, notwithstanding, to put the question at rest by having it tried in a variety of situations, and with the different kinds of crops; and that these trials should not be confined to one or two districts, but made throughout most of the corn counties of Scotland, under the inspection of the local agricultural societies. Such an arrangement, it is evident, was well calculated to make the merits of the implement extensively known, and, at the same time, to afford an opportunity to the labourers of almost every part of Scotland to learn how to work with it. Through the kind offices of M. the Chevalier Masclet, consul of France, two hands, the sons of small farmers, were engaged in French Flanders, and brought over at the expense of the society. They arrived at Edinburgh on the 12th of July; on the 15th, they were employed in reaping with the Hainault sythe on the farm of Lochend, belonging to Mr. Oliver, in the neighbourhood of the city, before a great concourse of spectators; and the day following they set out on the route assigned them by the society, through East Lothian, and the counties of Berwick and Roxburgh, practising one or two days near the principal towns. On the 22d they were at Dalkeith, from whence they were to proceed to Lanarkshire, Renfrewshire, the Carses of Stirling and Gowrie, and the counties of Fife, Forfar, Aberdeen, and Moray, and perhaps still farther north, if the duration of the harvest will admit of it. The members of the Highland Society, abounding in every part of Scotland, and most of them at this season, in the country, engaged to attend the trials in the several districts; while the local agricultural societies entered into the measure with a degree of spirit and liberality, (having offered, of their own accord, to relieve the Highland Society from part of the general expense,) which have not often been equalled, and which are to be found, to the same extent, and among the same class, in no other country than Britain. Still further to insure accurate and full reports, the Highland Society circulated printed queries, to direct the attention of those who attend the trials to the most important circumstances.

The following is the result of experiments made in East Lothian, Berwickshire, and Roxburghshire, that is, in the best cultivated counties in Scotland, in the following terms: "On the 16th and 17th, the use of the instrument was exhibited on the farm of Amisfield Mains near Haddington, in presence of the Marquis of Tweeddale, the Earl of Lauderdale, Mr. Hay of Spot, Mr. Hunter of Thurston, Mr. Balfour of Whittinghame, Mr. Rennie of Phantassie, Mr. Bogue of Woodhall, and many of the most eminent agriculturists in East Lothian; and we have been favoured by an intelligent spectator with the following account, accompanied by a few remarks:

"The first trial was made upon a field of strong wheat, and in two hours and a half the reapers cut down about a quarter of a Scots acre, though they were somewhat interrupted with stones. This trial satisfied the gentlemen present, that where land is free of stones, two reapers with the Hainault sythe might cut an acre of strong corn in a day, and that it will be cut closer, and with as little loss in shaking, as with the common sickle. On the second day the reapers cut some barley and oats; and though the superiority of the implement was not so evident as on the first occasion, (the corn being much lighter on the ground,) it was on the whole very satisfactory. They finished by another trial in the wheat field.

"There appeared some difference of opinion as to the advantage of using this implement on all occasions, but there is only one opinion as to its decided superiority in cutting strong standing corn. Care must be taken, however, to clear the land of stones; and where this is done, the crop will be cut closer, and as clean, with the Wainault sythe, as it can be by the modes practised in this country, and at considerably less expense.

"On the evening of the 17th, the party proceeded to Dunse; and next day exhibited, in a field of barley belonging to Mr. Logan, of Crumstain, in the presence of General Maitland, Mr. Hay, of Dunse Castle, and a number of the most respectable farmers in the neighbourhood. The barley was a heavy crop; and in an hour the two reapers cut 606 square yards, equal to one-eighth of an English acre, or at the rate of one acre three-eighths in a day of eleven hours. Those who witnessed the work stated, that it would require five of their best Irish reapers to cut the same quantity in the same time. The trial gave great satisfaction, and several gentlemen took immediate steps to enable some of their workmen to employ the sythe.

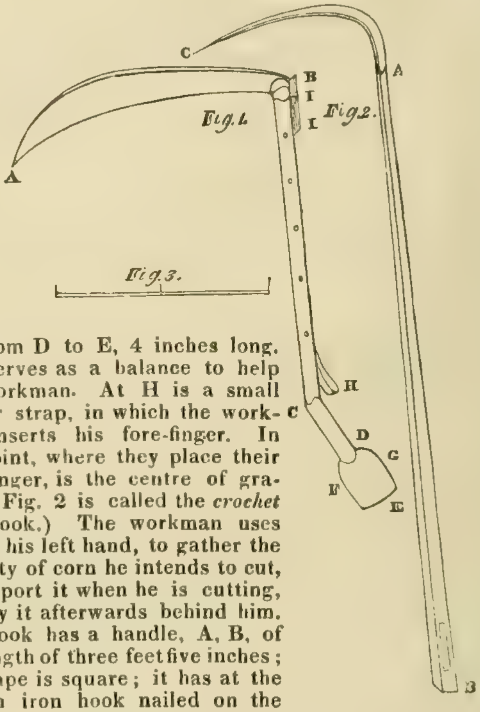
"Having arrived at Kelso on the evening of the 18th, arrangements were made for a short trial the next day, to suit the convenience of farmers attending the market; whilst Saturday, the 20th, was set apart for putting the abilities of the reapers to a full and fair test. Accordingly, on Friday afternoon, the use of the instrument was exhibited for about an hour, on Mr. Dudgeon's farm of Spylaw, to a very great concourse of spectators, all of whom appeared to take a most lively interest in the scene, and to derive much satisfaction from it. Next day the reapers were again upon the same ground about ten o'clock, and proceeded to work an hour on a very heavy crop of barley. They cut 726 square yards, which, on a day's work of ten hours, is at the rate of three-fourths of an English acre to each reaper. The ground was rather stony, and some impediment from the crowd was unavoidably sustained, otherwise, as asserted by the reapers, they would have done at the rate of an acre each at least. At first several binders tied and set up the sheaves; afterwards one man undertook the task, and performed it: but he declared he could not have gone on throughout the day, and it was evidently too much for one of the best workers to accomplish.

"The next trial took place upon some very light oats, and it certainly proved that the sythe was quite effectual on crops of that description, a fact which was very generally doubted. As there happened to be no wheat ready for cutting on Spylaw, the next and third trial was made upon a field of wheat near Kelso; a very fair crop, and the ground free from large stones. The day being far spent, the time was limited to a quarter of an hour, and the result was 212 yards, or at the rate of one acre and three-fourths, English measure, per day of ten working hours; and here again the obstructions from the crowd were very considerable. The whole corn taken down was cut closer to the ground, and cleaner, than by the sickle. Three of the best reapers with the sickle, cut an English acre per day, making also bands for the sheaves; but five are often found scarcely equal to the same work.

"These experiments were witnessed by a committee of the Highland Society, a Committee of the Union Agricultural Society, and a number of proprietors and eminent agriculturists; and at intervals a number of intelligent and active workers, who had been brought forward for the purpose, were allowed to use the scythes, and received instructions from the Flemings; and many of them shewed considerable expertness.

"The two young Flemings are sons of farmers in French Flanders, (where farms seldom much exceed 100 acres,) and their names are J. B. Dupre, and Luis Catteau, the first from the neighbourhood of Douay, the other from near Lille. Their behaviour is modest and unassuming; they are very intelligent, and shew a most praiseworthy anxiety for information, particularly in statistical and agricultural matters, on which they take numerous notes. They allege they cannot do so much work as the labourers in their own country, who depend solely for subsistence on their daily toil. To a question pointedly put to them, if the sythe could be used with advantage when the crop was on an acclivity? they unhesitatingly replied, 'Equally well as on a level piece of ground;' and offered to prove it.'

*Description of the Plate.* This implement, called in England the Hainault sythe, is known in French Flanders under the name of *Piquet*, or *Petite Faulx*, (small sythe.) It is composed of two parts, fig. 1 and 2. Fig 1 represents the piquet. The blade A to B, is 21 inches long and 2⅞ inches broad. The back is ⅜ of an inch thick. The blade is fixed into the handle by one or rather two wedges I, I. The handle from I to C is seventeen inches long. At C it is curved; the length from C D, 5½ inches. The part F, G, E, is, from F to G, 3⅛ inches wide, and from D to E, 4 inches long. This serves as a balance to help the workman. At H is a small leather strap, in which the workman inserts his fore-finger. In this point, where they place their fore finger, is the centre of gravity. Fig. 2 is called the *crochet* (the hook.) The workman uses it with his left hand, to gather the quantity of corn he intends to cut, to support it when he is cutting, and lay it afterwards behind him. This hook has a handle, A, B, of the length of three feet five inches; its shape is square; it has at the top an iron hook nailed on the wood: its length from A to C is 10⅝ inches. The small opening above B is for the purpose of inserting the blade, so as to prevent the workman being hurt, when carrying his implement.



# T.

**T**, the nineteenth letter of our alphabet. In Abbreviations, amongst the Roman writers, T. stands for Titus, Titius, &c. Tab. for Tabularius; Tab. P. H. C. for Tabularius provincis Hispaniæ citerioris; Tar. Tarquinius; Ti. Tiberius; Ti. F. Tiberii filius; Ti. L. Tiberii libertus; Ti. N. Tiberius Nepos; T. J. A. V. P. V. D. tempora judicem arbitrumve postulat ut det; T. M. P. terminum posuit; T. M. D. terminum dedicavit; Tr. trans. tribunus; Tr. M. or Mil. tribunus militum; T. R. P. L. D. E. S. triannus plebis designatus; T. R. A. E. R. tribunus ærarii; T. V. R. C. A. P. triumviri capitales; T. R. or TRIB. POT. tribunicia potestata; Tul. H. Tulus Hostilius.

**TABBY**, in Commerce, a kind of rich silk which has undergone the operation of tabbying; or being passed through a calender, the rolls of which are made of iron or copper, variously engraven; which bearing unequally on the stuff, renders the surface unequal, so as to reflect the rays of light differently, making the representation of waves thereon.

**TABLE**, in Perspective, denotes a plane surface, supposed to be transparent, and perpendicular to the horizon. It is always imagined to be placed at a certain distance between the eye and the objects, for the objects to be represented thereon by means of the visual rays passing from every point thereof through the table to the eye; whence it is called perspective plane.

**TABLE**, among the Jewellers. A table-diamond, or other precious stone, is that whose upper surface is quite flat, and the only sides cut in angles; in which sense, a diamond cut tablewise, is used in opposition to a rose-diamond.

**TABLE**, in Mathematics, systems of numbers calculated to be ready at hand for the expediting astronomical, geômetrical, and other operations: thus, we say tables of the stars; tables of sines, tangents, and secants; tables of logarithms, rhumbs, &c.; sexagenary tables.

**TABLING**, a sort of broad hem, formed on the heads, skirts, and bottoms of a ship's sails, to strengthen them in that part which is attached to the bolt-rope.

**TACCA**, a genus of the class and order hexandria monogynia.

**TACHYGRAPHY**, the art of writing fast, or of short hand; of which authors have invented several methods.

**TACK**, a rope used to confine the foremost lower corners of the courses and stay-sails, in a fixed position, when the wind crosses the ship's course obliquely. The same name is also given to the rope employed to pull out the lower corner of a studding-sail to the extremity of its boom. The main sail and fore-sail of a ship are furnished with a tack on each side, which is formed of a thick rope, tapering to the end, and having a knot wrought upon the largest end, by which it is firmly retained in the clue of the sail; the tack therefore extends the sail to windward, while the sheet extends it to leeward.

**Tack**, is also applied, by analogy, to that part of any sail to which the tack is usually fastened. A ship is said to be on the starboard or larboard tack, when she is close-hauled with the wind on the starboard or larboard side, and in this sense the distance she sails in that position is considered as the length of the tack, although this is more frequently called a board. *To Tack*, to change the course from one board to another, or turn the ship about from the starboard to the larboard tack, or *vice versa*, in a contrary wind. It is performed by turning the ship's prow suddenly to the wind, whereby her head-sails being thrown aback, they receive the impression of the wind in a new direction, and cause her to fall off from the wind to the other tack.

**TACKING**, is also used in a more enlarged sense, to imply that manœuvre by which a ship makes an oblique progression to windward, in a zig-zag direction; this, however, is more usually called beating or turning to windward. The operation of tacking is thus performed: the helm being put to the lee-side, the commanding-officer calls out, 'Helm a-lee;' the head-sails are immediately made to shiver in the wind, by casting loose their sheets and bow-lines; the officer then calls, 'Raise tacks and sheets,' which is executed by loosening all the ropes which confine the corners of the lower sails, in order that they may be more readily shifted to the other side. When the ship has turned her head directly to the wind, the order is given to turn about the sails on the mizzen-mast, by the exclamation, 'Haul main-sail, haul;' the bow-lines and braces are then instantly let go on one side, and as expeditiously drawn in on the other side, so as to wheel the yards about their masts; the lower corner of the main-sail is, by means of its tack, pulled down to its station at the chess-tree, and the after-sails are at the same time adjusted to stand upon the other board. Finally, when the ship has fallen off five or six points, the commanding-officer calls, 'Haul off all,' or, 'Let go and haul;' then the sails on the foremast are wheeled about by their braces, and as the ship has a tendency to fall off, she is checked by the effort of the helm, which is for that purpose shifted to the now lee-side. The fore-tack, or lower corner of the foresail, being fixed in its place, the bowlines are hauled, and the other sails are properly arranged to the wind, which is called trimming all sharp. In order to explain the theory of tacking a ship, it may be necessary to premise a known axiom in natural philosophy, that every body will persevere in a state of rest, or of moving uniformly in a right line, unless it be compelled to change its state by forces impressed, and that the change of motion is proportional to the moving force impressed, and is made according to the right line in which that force is exerted. By this principle it is easy to conceive how a ship is compelled to turn in any direction by the force of the wind acting upon her sails in horizontal lines. For the sails may be so arranged as to receive the current of air either directly, or more or less obliquely; hence the motion communicated to the sails must of necessity conspire with that of the wind upon their surfaces. To make the ship tack, or turn round with her head to the windward, it is therefore necessary, after she has received the first impression from the helm, that the head-sails should be so disposed as to diminish the effort of the wind, in the first instant of her motion, and that the whole force of the wind should be exerted on the after-sails, which, operating on the ship's stem, carries it round like a weathercock. But since the action of the after-sails to turn the ship will unavoidably cease when her head points to the windward, it then becomes necessary to use the head-sails to prevent her from falling off, and returning to her former situation. These are accordingly laid aback on the lee-side, to push the vessel's forepart towards the appointed side till she has fallen into the line of her course thereon, and fixed her sails to conform with that situation.

**TACKLE**, a machine formed by the communication of a rope with an assemblage of blocks, and known in mechanics by the name of pulley. Tackles are used in a ship to raise, remove, or secure weighty bodies, to support the masts, or to extend the sails and rigging; they are moveable, as communicating with a runner, or fixed, as being hooked in an immoveable situation; and they are more or less complicated in proportion to the effects which they are intended to produce. The application of the tackle to mechanical purposes is called hoisting or bowsing. *Ground Tackle*, implies the anchors, cables, &c. *Tack Tackle*, a small tackle used to pull down the tacks of the principal sails to their respective stations, and particularly attached to the main-sails of brigs, sloops, cutters, and schooners. For various other tackles, see their particular epithets.

**TACTICS**, in the art of War, is the method of disposing forces to the best advantage in order of battle, and of performing the several military motions and evolutions.

**TÆNIA**, in Natural History, *Tape Worm*. Gmelin has enumerated almost one hundred species, besides varieties: he has divided them into sections. A. Those found in other parts besides the intestines, and furnished with a vesicle behind. B. Those found in the intestines only, and without a terminal vesicle. C. Those with the head unarmed with hooks. The worms of the first section are found infesting mammalia, reptiles, and fish. Those of the second section are found in the mammalia, in birds, and in fish; and those of the third section infest mammalia, birds, reptiles, and fish. This genus of worms are destined to feed on the juices of various animals, and are usually found in the alimentary canal, generally at the upper part of it. They are sometimes found in great numbers, and occasion the most distressing disorders. They have the power of reproducing parts which have been broken off, and are therefore removed with the utmost difficulty: they are oviparous, and discharge their eggs from the apertures on the joints.

**TAFFAREL**, the uppermost part of a ship's stern, being a curved piece of wood, and usually ornamented with some device in sculpture.

**TAIL OF A GALE**, a name given by sailors to the latter part of a storm, wherein its violence is considerably abated.

**TAIL-*Block***, a single block. having a short piece of rope attached to it, by which it may be fastened to any object at pleasure, either for conveyance, or to increase the force applied to the said object.

**TAKING-IN**, among Seamen, the act of brailing up and furling the sails at sea, particularly when the wind increases; and is generally used in opposition to setting.

**TALC**, in Mineralogy, a stone, the characters of which are, a specific gravity between 3·5834 and 2·9902; a texture easy to be scraped with the knife; a soft and unctuous surface; the primitive form of a right rhomboidal prism, its bases having angles of 120 degrees and 60 degrees, and in which sections parallel with these bases are easily obtained. Its integrant molecule has the same form.

**TALENT**, a money of account amongst the ancients, equal to £342 sterling. Among the Jews, a talent in weight was equal to 60 maneh, or 113 pounds, 10 ounces, 1 pennyweight, 10 and two-seventh grains.

**TALES** is used in Law, for a supply of men impannelled on a jury, and not appearing, or on their appearance challenged and disallowed, when the judge, upon motion, orders a supply to be made by the sheriff of one or more such persons present in court, to make up a full jury.

**TALLOW**, animal fat melted down and clarified; but the name is frequently given to this unctuous substance in its most simple state. After domestic purposes are supplied, the great consumption is in the making of soap and candles, and in the dressing of leather.

**TALLOW *Tree***. In China this tree grows in great abundance. It is about the height of a pear tree, and in habit it resembles that of the cherry. The seeds, which are numerous, are separated from the white substance in which they are enclosed, by being steeped ten or fifteen days in water; after which, being put into a press, a glutinous oil drops from them, which soon hardens into the consistence of animal tallow. The seed is also sometimes boiled in water, when the oil is found floating on its surface. Candles made of this substance are very white, and, according to Sir George Staunton, are firmer than those of common tallow, as well as free from all offensive odour; but he thinks them inferior to such as are made of wax or spermaceti. The Chinese frequently colour this tallow with vermilion, to add to its beauty.

**TALLY**, a piece of wood, on which retailers cut notches to mark the goods delivered out on credit. Tallies are taken as evidence in courts of justice, as much as books.

**TALLYING-Aft**, a phrase applied to the act of pulling aft the sheets or lower corners of the main-sail and fore-sail.

**TALMUD**, or Thalmud, among the Jews, a collection of the doctrines of their religion or morality.

**TALPA**, the Mole, a genus of quadrupeds of the order feræ. The common mole is about six inches in length, without the tail. Its body is large and cylindrical, and its snout strong and cartilaginous. Its skin is of extraordinary thickness, and covered with a fur, short, but yielding to that of no other animal in fineness. It hears with particular acuteness, and, notwithstanding the popular opinion to the contrary, possesses eyes, which it is stated to be able to withdraw or project at pleasure. It lives partly on the roots of vegetables, but principally on animal food, such as worms and insects, and is extremely voracious and fierce. Shaw relates, from Sir Thomas Brown, that a mole, a toad, and a serpent, have been repeatedly enclosed in a large glass vase, and that the mole has not only killed the others, but has devoured a very considerable part of them. It abounds in soft ground, in which it can dig with ease, and which furnishes it with the greatest supply of food. It forms its subterraneous apartments with great facility, by its snout and feet, and with a very judicious reference to escape and comfort. It produces four or five young in the spring, in a nest a little beneath the surface, composed of moss and herbage. It is an animal injurious to the grounds of the farmer, by throwing up innumerable hills of mould, in the construction of its habitation, or the pursuit of its food; and many persons obtain their subsistence from the premiums which are, on this account, given for their destruction. Moles can swim with considerable dexterity, and are thus furnished with the means of escape in those sudden inundations to which they are frequently exposed. In Ireland, the mole is unknown.

**TAMARICK**, a large shrub much used in some parts in making quickset hedges. The French sort is chiefly used.

**TAMARINDUS**, the *Tamarind Tree*, a genus of plants arranged by Linnæus under the class of triandria and order of monogynia. The timber of the tamarind tree is heavy, firm, and hard; sawn into boards, it is converted to many useful purposes in building. The fruit is used both in food and medicine. In many parts of America, particularly in Curaçoa, they eat abundance of it raw, without any inconvenience. In Martinico also, they eat the unripe fruit, even of the most austere kind.

**TAMBAC**, a mixture of gold and copper, which the people of Siam hold more beautiful and valuable than gold itself.

**TAMBOUR**, in Architecture, a term applied to the Corinthian and Composite capitals.

Tambour, in the Arts, is a species of embroidery, in which threads of gold, silver, and silk, are formed into leaves, flowers, or other figures.

**TAMPING**, in Mining, is the clay, or other matter, rammed into a hole made in a rock, for blasting with gunpowder.

**TAMPION**, or Tompion, a stopple or plug which closes up a hole in a vessel. In Gunnery, it is a wooden cylinder put into the muzzles of cannon, &c. to prevent the dust or wet from entering.

**TAN**, the bark of the oak chopped and ground in a tanning mill into a coarse powder, to be used in the tanning of leather.

**TANGENT**, in Geometry, is defined, in general, to be a right line, which touches any arch of a curve, in such a manner that no right line can be drawn betwixt the right line and the arch.

**TANNIN.** This, which is one of the immediate principles of vegetables, was first distinguished by Seguin from the gallic acid, with which it had been confounded under the name of the astringent principle. He gave it the name of tannin, from its use in the tanning of leather, which it effects by its characteristic property, that of forming with gelatin a tough insoluble matter.

**TANNING.** The several kinds of leather are prepared from the skins of animals, macerated for a long time with lime and water, to promote the separation of the hair and wool, and of the fat and fleshy parts, in which recourse is also had to the assistance of mechanical pressure, scraping, and the like. The skin, when thus deprived of its moist putrescible part, and brought considerably toward the state of mere fibre, is tanned by maceration with certain astringent substances, particularly the bark of the oak tree.—The hide consists almost wholly of gelatin, and all that is necessary is, to divest it of the hair, epidermis, and any flesh or fat adhering to it. This is commonly done, after they have been soaked in water some time, and handled or trodden to cleanse them from filth, by immersing them in milk of lime. Some, instead of lime, use an acescent infusion of barley or rye meal, or spent tan; and others recommend water acidulated with sulphuric acid. Similar acidulous waters are afterwards employed for raising or swelling the hide, when this is necessary. The skins thus prepared, are finally to undergo what is properly called the tanning. This is usually done by throwing into a pit, or cistern, made in the ground, a quantity of ground oak bark that has already been used, and on this the skins and fresh bark in alternate layers, covering the whole with half a foot of tan, and treading it well down. The tanning may be accelerated by adding a little water.

**TANTALITE**, a metallic fossil. Colour between bluish-grey and blackish-grey. Surface smooth, with some lustre. Lustre metallic. Fracture compact. Streak blackish grey, approaching brown. Very hard. Not magnetic. Specific gravity 7.953. Composed of the oxides of tantalian, iron, and manganese.

**TANTALUS**, the *Ibis*, in Natural History, a genus of birds of the order grallæ. There are nineteen species, of which we shall notice the following. T. loculator, the wood ibis, is of the size of a goose, and the T. ibis or the Egyptian ibis, is more than three feet long, and as large as a stork. On the retreating of the Nile, it is found in Lower Egypt in great numbers, subsisting on insects and frogs. It perches on palm trees, and sleeps in an erect attitude, its tail touching its legs. It is supposed by some naturalists to be the ibis of the ancients, and is known to destroy and devour serpents.

**TAPESTRY**, a kind of woven hangings of wool and silk, frequently raised and enriched with gold and silver, representing figures of men, animals, landscapes, histories, &c.

**TAPIR**, the name of an animal found in some parts of America. In size, it is about that of a stout calf, and in shape bears some resemblance to a hog.

**TAPPING**, the act of piercing a tree or barrel, to extract its juices or liquor. In Surgery, it is an operation performed on dropsical persons.

**TAR**, a thick, black, unctuous substance, obtained from old pines and fir trees by burning them with a smothering heat.

Tar, a kind of liquid gum, which is procured from pines or fir-trees, and is used to pay the sides of ships and boats, and their rigging and yards, in order to preserve them from the effects of the weather.

**TARANTULA**, a species of spider, the bite of which it is extremely difficult to cure; and, even after a cure has been effected, the patient has usually some annual affection, from the latent poison of the insect.

**TARE**, in Agriculture, a plant of the vetch kind, of which there are two sorts.

**TARE**, is an allowance for the outside package that contains such goods as cannot be unpacked without detriment; or for the papers, threads, bands, &c. that enclose or bind any goods, imported loose; or though imported in casks, chests, &c. yet cannot be unpacked and weighed net.

**TARGIONIA**, a genus of plants of the class of cryptogamia, and natural order of algæ.

**TARGUM**, a name whereby the Jews call the Chaldee paraphrases or expositions of the Old Testament, in the Chaldee language.

**TARIFF**, a table or catalogue usually drawn in an alphabetical order, containing the names, and amount of duties paid on several kinds of merchandise.

**TARPAWLING**, a broad piece of canvass, well daubed with tar, and used to cover the hatchways of a ship at sea, to prevent the penetration of the rain or sea-water, which may at times rush over the decks.

**TARRAS**, or **TERRAS**. A volcanic earth used as a cement. It does not differ much in its principles from puzzolana; but it is much more compact, hard, porous, and spongy. It is generally of a whitish-yellow colour, and contains mere heterogeneous particles, as spar, quartz, schorl, &c. and something more of a calcareous earth. It effervesces with acids, is magnetic, and fusible *per se*. When pulverized, it serves as a cement, like puzzolana. It is found in Germany and Sweden. *See* LIME.

**TARTAN**, a small coasting vessel navigated in the Mediterranean sea, and having only one mast and a bowsprit, the principal sail, which is very large, being extended by a lateen yard.

**TARTAR**, or, according to the new chemistry, *tartrat of potass*, is obtained in a state of impurity, incrusted on the bottom and sides of casks in which wine has been kept. It is afterwards purified by dissolving it in boiling water, and filtering it while hot. On cooling, it deposits the pure salt in very irregular crystals. In this state it is sold under the name of crystals or cream of tartar.

**TARTARIC ACID**. Scheele was the first who obtained this acid in a separate state. He communicated his process for obtaining it to Retzius, who published it in the Stockholm Transactions for 1770. It consisted in boiling tartar with lime, and in decomposing the tartrat of lime thus formed by means of sulphuric acid. The process employed at present for obtaining tartaric acid, which is the same with that of scheele, is the following:—Dissolve tartar in boiling water, and add to the solution powdered chalk till all effervescence ceases, and the liquid ceases to redden vegetable blues. Let the liquid cool, and then pass it through a filtre. A quantity of tartrat of lime (which is an insoluble white powder) remains upon the filtre. Put this tartrat, previously well washed, into a glass cucurbite, and pour on it a quantity of sulphuric acid equal to the weight of the chalk employed, which must be diluted with water. Allow it to digest for twelve hours, stirring it occasionally. The sulphuric acid displaces the tartaric; sulphat of lime remains at the bottom, while the tartaric acid is dissolved in the liquid part. Decant off this last, and try whether it contains any sulphuric acid; this is done by dropping in a little acetat of lead; a precipitate appears which is insoluble in acetic acid, if sulphuric acid is present, but soluble if it is absent. If sulphuric acid is present, the liquid must be digested again on some more tartrat of lime; if not, it is to be slowly evaporated, and about one-third part of the weight of the tartar employed is obtained of crystallized tartaric acid.

**TARTRATS**, salts formed with the tartaric acid.

**TASTE**, a sensation excited by means of the organs of this sense, the papillæ of the tongue, &c. Taste is also used in a figurative manner for the judgment and discernment of the mind.

**TAUGHT**, the state of being extended or stretched out, and is usually applied in opposition to slack.

**TAUGHT** *Sail*, implies a great quantity of set sail.

**TAUNT**, an epithet, at sea, signifying high or tall. It is particularly expressed of the masts, when they are of an extraordinary length, as square is applied to the yards on the same occasion.

**TAURUS**, the *Bull* ♉, is the second of the spring signs, and the sun enters it, according to the fixed zodiac of Hipparchus, on the 20th of April; but reckoning by the moveable zodiac, or the recession of the equinoxes, the transit takes place about the 12th of May. The earth is now in Scorpio, and the Sun as seen from the earth appears in Taurus, the north pole comes now more into the light, and the days increase as the nights decrease in length, at all places N of the Equator. On the 5th of May the earth is in the 15th degree of Scorpio, and the sun as seen from the earth appears in the 15th degree of Taurus. The tropic of Cancer is now in the light from a little after 5 o'clock in the morning, till about 7 in the evening; the parallel of London, from half an hour past 4, till half an hour past 7; the polar circle from 3 till 9; and a large tract round the N pole has day all the 24 hours, for many rotations of the earth on its axis. The Hyades and Pleiades, though denominated constellations, are integral parts of Taurus.

*Boundaries and Contents*. N. by Perseus and Auriga; E by Gemini; S. by Orion and Eridanus; and W. by Aries. There are 141 stars in this constellation.

**TAUTOLOGY**, a needless repetition of the same sense in different words.

**TAWING**, the art of dressing the skins of sheep, lamb, kid, and goats, in white, for divers manufactures, particularly gloves.

**TAX**, an impost laid by government on almost every thing.

**TAXUS**, in Botany, *Yew Tree*, a genus of the dioecia monodelphia class and order. Natural order of coniferæ. The yew-tree is a native of Europe, North America, and Japan; its proper situation is in mountainous woods, or more particularly the clefts of high calcareous rocks. England formerly possessed great abundance, and it is now not very uncommon in a wild state, in some parts of the country. Of planted trees there are yet several in church-yards.

**TEA**, a valuable shrub, that abounds in China and Japan. Its leaves only are imported into Europe, the infusion of which is too well known to require any particular description. The difference in the qualities of tea is generally thought to arise from the season in which the leaves are gathered, and the manner in which they are preserved. The consumption of this article, in England alone, is almost incredible.

**TEAK**, a valuable timber which abounds in various parts of the East Indies, and is applied to domestic and nautical purposes. Ships built with teak are far more durable in the Indian seas than those made of English oak.

**TEAL**, the smallest species of bird of the duck kind.

**TEAM**, the number of horses, oxen, or other animals, united together to draw a cart, waggon, or other carriage.

**TEASEL**, a species of plant much used in cloth manufactories, for raising the nap on the article made. It is much cultivated in those districts, but in others it is considered as a weed, and destroyed.

**TECHNICAL**, expresses somewhat relating to arts and sciences; in this sense we say technical terms. It is also particularly applied to a kind of verses wherein are contained the rules or precepts of any art, thus digested to help the memory to retain them.

**TEETH**. The basis of the substance that forms the teeth, like that of other bones, appears to be phosphate of lime. The enamel, however, according to Mr. Hatchett, differs from other bony substances in being destitute of cartilage; for raspings of enamel, when macerated in diluted acids, he found were wholly dissolved; while raspings of bone, treated in the same manner, always left a cartilaginous substance untouched.

**TELEGRAPH**, is the name very properly given to an instrument, by means of which information may be almost instantaneously conveyed to a considerable distance. The telegraph, though it has been generally known and used by the moderns only for a few years, is by no means a modern invention. There is reason to believe that amongst the Greeks there was some sort of telegraph in use. A Greek play begins with a scene, in which a watchman descends from the top of a tower in Greece, and gives the information that Troy was taken: "I have been *looking out* these ten years (says he) to see when that would happen, and this night it is done." Of the antiquity of a mode of conveying intelligence quickly to a great distance, this is certainly a proof. The Chinese, when they send couriers on the great canal, or when any great man travels there, make signals by fire from one day's journey to another, to have every thing prepared; and most of the barbarous nations used formerly to give the alarm of war by fires lighted on the hills or rising grounds. Polybius calls the different instruments, used by the ancients for communicating information, fire-signals.

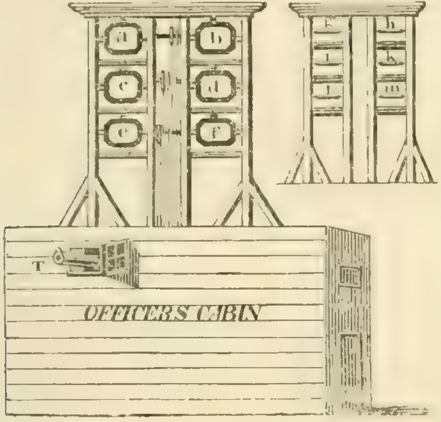
A new method, invented by Cleoxenus, (others say Democritus,) and very much improved by Polybius, as he himself informs us, is as follows: Take the letters of the (Greek) alphabet, and divide them into five parts, each of which will consist of five letters, except the last division, which will have only four. Let these be fixed on a board in five columns. The man who is to give the signals, is then to begin by holding up two torches, which he is to keep aloft till the other party has also shewn two. This is only to shew that both sides are ready. These first torches are then withdrawn. Both parties are provided with boards, on which the letters are disposed as formerly described. The person, then, who gives the signal, is to hold up torches on the left, to point out to the other party from what column he shall take the letters as they are pointed out to him. If it is to be from the first column, he holds up one torch; if from the second, two; and so on for the others. He is then to hold up torches on the right, to denote the particular letter of the column that is to be taken. All this must have been agreed on beforehand. The man who gives the signals must have an instrument consisting of two tubes, and so placed as that, by looking through one of them, he can see only the right side, and through the other only the left, of him whom he is to answer. The board must be set up near this instrument; and the station on the right and left must be surrounded with a wall ten feet broad, and about the height of a man, that the torches raised above it may give a clear and strong light, and that when taken down they may be completely concealed. Let us now suppose that this information is to be communicated—*A number of the auxiliaries, about a hundred, have gone over to the enemy.* In the first place, words must be chosen that will convey the information in the fewest letters possible; as, *A hundred Cretans have deserted*, Κρετες εκατον αφ' ημων ηυτομολησαν. Having written down this sentence, it is conveyed in this manner: The first letter is a K, which is in the second column; two torches are therefore to be raised on the left hand, to inform the person who receives the signals to look into that particular column. Then five torches are to be held up on the right, to mark the letter *k*, which is the left in the column. Then four torches are to be held up on the left, to point out the ρ (*r*), which is in the fourth column, and two on the right, to shew that it is the second letter of that column. The other letters are pointed out in the same manner. Such was the *pyrsia* or telegraph recommended by Polybius.—But neither this, nor any other method mentioned by the ancients, seems ever to have been brought into general use; nor does it appear, that the moderns had thought of such a machine as a telegraph till the year 1663, when the Marquis of Worcester, in his Century of Inventions, affirmed that he had discovered "a method by which, at a window, as far as eye can discover black from white, a man may hold discourse with his correspondent, without noise made or notice taken; being, according to occasion given, or means afforded, *ex re nata*, and no need of provision beforehand; though much better if foreseen, and course taken by mutual consent of parties." This could be done only by means of a telegraph, which, in the next sentence, is declared to have been rendered so perfect, that by means of it the correspondence could be carried on "by night as well as by day, though as dark as pitch is black."

Dr. Hooke, whose genius as a mechanical inventor was perhaps never surpassed, delivered a "Discourse to the Royal Society, May 21, 1684, shewing a way how to communicate one's mind at distances," of 30, 40, 100, 120, &c. miles, "in as short a time almost as a man can write what he would have sent." He takes to his aid the then recent invention of the telescope, and explains the method by which characters exposed at one station may be rendered plain and distinguishable at the others. He directs, "First, for the stations; if they be far distant, it will be necessary that they should be high, and lie exposed to the sky; that there be no higher hill, or part of the earth beyond them, that may hinder the distinctness of the characters that are to appear dark, the sky beyond them appearing white; by which means also the thick and vaporous air near the ground will be passed over and avoided." "Next, the height of the stations is advantageous, upon the account of the refractions or inflections of the air." "Next, in choosing of these stations, care must be taken, as near as may be, that there be no hill that interposes between them, that is almost high enough to touch the visible ray; because in such cases the refraction of the air of that hill will be very apt to disturb the clear appearance of the object." "The next thing to be considered is, what telescopes will be necessary for such stations." "One of these telescopes must be fixed at each extreme station, and two of them in each intermediate; so that a man for each glass, sitting and looking through them, may plainly discover what is done in the next adjoining station, and with his pen write down on paper the characters there exposed in their due order; so that there ought to be two persons at each extreme station, and three at each intermediate; so that, at the same time, intelligence may be conveyed forwards and backwards." "Next, there must be certain times agreed on, when the correspondents are to expect; or else there must be set at the top of the pole, in the morning, the hour appointed by either of the correspondents for acting that day: if the hour be appointed, pendulum clocks may adjust the moment of expectation and observing." "Next, there must be a convenient apparatus of characters, whereby to communicate any thing with great ease, distinctness, and secrecy. And those must be either day characters or night characters." The day characters "may all be made of three slit deals;" the night characters "may be made with links, or other lights, disposed in a certain order." The doctor invented twenty-four simple characters, each constituted of right lines, for the letters of the alphabet; and several single characters, made up of semicircles, for whole sentences. He recommended, that three very long masts or poles should be placed vertically, and joined at top by one strong horizontal beam; that a large screen should be placed at one of the upper corners of this frame, behind which all the deal-board characters should hang, and by the help of proper cords should quickly be drawn forwards to be exposed, and then drawn back again behind the screen. "By these means," says the doctor, "all things may be made so convenient, that the same character may be seen at Paris, within a minute after it hath been exposed at London, and the like in proportion for greater distances; and that the characters may be exposed so quick after one another, that a composer shall not much exceed the exposer in swiftness." Among the uses of this contrivance, the inventor specifies these: "The first is for cities or towns besieged; and the second for ships upon the seas; in both which cases it may be practised with great certainty, security, and expedition." The whole of Dr. Hooke's paper was published in Derham's collection of his *Experiments* and *Observations*; from which it appears, that he had brought the telegraph to a state of far greater maturity and perfection than M. Amonton's, who attempted the same thing about the year 1702; and indeed to a state little inferior to several which have been proposed during the last twenty years.

During the French revolution the telegraph was applied to useful purposes. Whether M. Chappe, who is said to have invented the telegraph first used by the French about the end of 1793, knew any thing of Hooke's or of Amonton's invention, it is impossible to say; but his telegraph was constructed on principles nearly similar. The manner of using this telegraph was as follows:—At the first station, which was on the roof of the palace of the Louvre at Paris, M. Chappe, the inventor, received in writing, from the committee of public safety, the words to be sent to Lisle, near which the French army at that time was. An upright post was erected on the Louvre, at the top of which were two transverse arms, moveable in all directions by a single piece of mechanism, and with inconceivable rapidity. He invented a number of positions for these arms, which stood as signs for the letters of the alphabet; and these, for the greater celerity and simplicity, he reduced in number as much as possible. The grammarian will easily conceive, that sixteen signs may amply supply all the letters of the alphabet, since some letters may be omitted, not only without detriment, but with advantage. These signs, as they were arbitrary, could be changed every week, so that the sign of B for one day might be the sign of M the next; and it was only necessary that the persons at the extremities should know the key. The intermediate operators were only instructed generally in these sixteen signals; which were so distinct, so marked, so different the one from the other, that they were easily remembered. The construction of the machine was such, that each signal was uniformly given in precisely the same manner at all times: it did not depend on the operator's manual skill; and the position of the arm could never, for any one signal, be a degree higher or a degree lower, its movement being regulated mechanically. M. Chappe having received at the Louvre the sentence to be conveyed, gave a known signal to the second station, which was Mont Martre, to prepare. At each station there was a watch-tower, where telescopes were fixed, and the person on watch gave the signal of preparation which he had received, and this communicated successively through all the line, which brough them all into a state of readiness. The person at Mont Martre then received, letter by letter, the sentence from the Louvre, which he repeated with his own machine; and this was again repeated from the next height, with inconceivable rapidity, to the final station at Lisle.

Two working models of this instrument were executed at Frankfort, and sent by Mr. W. Playfair to the Duke of York; and hence the plan and alphabet of the machine came to England, where various experiments were in consequence tried upon telegraphs, and one was soon after set up by government in a chain of stations from the Admiralty-office to the sea-coast. It consists of six octagon boards,* each of which is poised upon an axis in a frame, in such a manner that it can be either placed vertically, so as to appear with its full size to the observer at the nearest station, as in fig. 1, or it becomes invisible to him by being placed horizontally, as in fig. 2, so that the narrow edge alone is exposed, which narrow edge is from a distance invisible. Fig. 2 is a representation of this telegraph with the parts all shut and the machine ready to work. T, in the officer's cabin, is the telescope pointed to the next station. Fig. 2, is a representation of the machine not at work, and with the ports all open.

*Fig. 1.* *Fig. 2.*



The opening of the first port (fig. 1,) expresses *a*, the second *b*, the third *c*, the fourth *d*, the fifth *e*, and the sixth *f*, &c. Six boards make 36 changes, by the most plain and simple mode of working: and they will make many more, if more were necessary; but as the real superiority of the telegraph over all other modes of making signals consists in its making letters, we do not think that more changes than the letters of the alphabet, and the ten arithmetical ciphers, are necessary; but, on the contrary, that those who work the telegraphs should avoid communicating by words or signs agreed upon to express sentences; for that is the sure method never to become expert at sending unexpected intelligence accurately. Several other telegraphs have been proposed to remedy the defects to which the instrument is still liable. The dial-plate of a clock would make an excellent telegraph, as it might exhibit 144 signs so as to be visible at a great distance. A telegraph on this principle, with only six divisions instead of twelve, would be simple and cheap and might be raised 20 or 30 feet high above the building, without any difficulty; it might be supported on one post, and therefore turn round, and the contrast of colours would always be the same.

A very ingenious improvement of the telegraph has been proposed in the Gentleman's Magazine; it consists of a semicircle to be properly elevated, and fixed perpendicularly on a strong stand. The radius 12 feet; the semicircle consequently somewhat more than 36. This is to be divided into 24 parts. Each of these will therefore comprise a space of 18 inches, and an arch of 7° 30′ on the circumference. These 24 divisions to be occupied by as many circular apertures of six inches diameter; which will leave a clear space of six inches on each side between the apertures. These apertures beginning from the left, to denote the letters of the alphabet, omitting K, J, consonant, V, X, and Q, as useless for this purpose. There are then 21 letters. The four other spaces are reserved for signals.

The instrument to have an index moveable by a windlass on the centre of the semicircle, and having two tops, according as it is to be used in the day or night; one, a circular top of lacquered iron or copper, of equal diameters with the apertures (and which consequently will eclipse any of them against which it rests); the other a spear or arrow-shaped top, black, and highly polished, which in standing before any of the apertures in the day-time will be distinctly visible. In the night, the apertures to be reduced by a diaphragm sitting close to each so as to leave an aperture of not more than two inches diameter. The diaphragm to be of well-polished tin; the inner rim lacquered black half an inch. All the apertures to be illuminated, when the instrument is used in the night-time, by small lamps; to which, if necessary according to circumstances, convex lenses may be added, fitted into each diaphragm, by which the light may be powerfully concentrated and increased. Over each aperture one of the five prismatic colours least likely to be mistaken (the remaining two being less distinguishable, and not wanted, are best omitted) to be painted; and, in their natural order, on a width of eighteen inches and a depth of four, red, orange, yellow, green, blue; or, still to heighten the contrast, and render immediately successive apertures more distinguishable, red, green, orange, blue, yellow. The whole inner circle beneath and between the apertures to be painted black.

When the instrument is to be used, the index to be set to the signal apertures on the right. All the apertures to be covered or dark when it begins to be used, except that which is to give the signal. A signal gun to be fired, to apprize the observer. If the index is set to the first aperture, it will denote that words are to be expressed; if to the second, that figures; if to the third, that the figures cease; and that the intelligence is carried on in words. When figures are to be expressed, the alternate apertures from the left are taken in their order, to denote from 1 to 10 inclusively; the second from the right denotes 100; the fifth 1000. This order, and these intervals, are taken, to prevent any confusion in so peculiarly important an article of the intelligence to be conveyed.

| A | B | D | E | F | G |
|---|---|---|---|---|---|
| 0<br>000 | 0<br>0 00 | 0<br>00 0 | 0<br>000 | 000<br>0 | 0 00<br>0 |

| I | K | L | M | N | O |
|---|---|---|---|---|---|
| 00 0<br>0 | 000<br>0 | 00<br>00 | 0 0<br>0 0 | 0 0<br>00 | 00<br>00 |

| P | R | S | T | U | Y |
|---|---|---|---|---|---|
| 0 0<br>0 0 | 00<br>0 0 | 00<br>0 0 | 0<br>00<br>0 | 0 0<br>00 | 0<br>00<br>0 |

Perhaps, however, few of the telegraphs hitherto offered to the public exceed the preceding, either in its simplicity, cheapness, or facility in working; and it might, perhaps, with a few trifling additions, be made exceedingly distinct. It is thus described in the *Repertory of Arts and Manufactures.* For a nocturnal telegraph let there be four large patent reflectors, lying on the same plane, parallel to the horizon, placed on the top of an observatory. Let each of these reflectors be capable, by means of two winches, either of elevation or depression to a certain degree. By elevating or depressing one or two of the reflectors, eighteen very distinct arrangements may be produced, as the preceding scheme will explain.

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* The form is now altered, and a single pole with moveable arms conveys intelligence.

For the sake of example, the above arrangements are made to answer to the most necessary letters of the alphabet; but alterations may be made at will, and a greater number of changes produced, without any addition to the reflectors. In the first observatory there need only be a set of single reflectors; but in the other, each reflector should be double, so as to face both the preceding and subsequent observatory; and each observatory should be furnished with two telescopes. The proper diameter of the reflectors and their distance from each other will be ascertained by experience; and it must be observed, that each reflector, after every arrangement, must be restored to its place. To convert this machine into a diurnal telegraph, nothing more is necessary, than to insert in the place of the reflectors, gilt balls or any other conspicuous bodies.—Since these inventions were made public, telegraphs have been brought to so great a degree of perfection, that they now convey information speedily and distinctly, and are so much simplified that they can be constructed and maintained at little expense.

The advantages, too, which result from their use, are almost inconceivable. Not to speak of the speed with which information is communicated and orders given in time of war, by means of them, the whole kingdom could be prepared in an instant to oppose an invading enemy. A telegraph might also be used by commercial men to convey a commission cheaper and speedier than an express can travel. An establishment of telegraphs might be made like that of the post; and instead of being an expense, it would produce a revenue. Something of this kind was about ten years ago set up, to facilitate the intercourse between Norwich and Yarmouth.—*Dr. Gregory's Mechanics.*

**TELESCOPE.** Under the article Optics, the character, use, and power of this valuable instrument, have been introduced to the reader's notice. We shall now advert to two remarkably constructed telescopes,—that of Fraunhofer, and that of Dollond. The great discovery of a method of making flint glass in large pieces, and perfectly pure and free from striæ, which was made by the late M. Guinand, may be considered as forming an era in the history of the achromatic telescope. By means of this glass, M. Fraunhofer, the director of the Optical Institute or manufactory at Benedictbauern, near Munich, has constructed achromatic telescopes far superior to any that have hitherto been made; and we have been assured, that this eminent artist can now make achromatic object-glasses with an aperture of eighteen inches. But it is not merely in the optical part of the instrument that M. Fraunhofer has been successful. His various improvements on the apparatus which accompanies the telescope, and his ingenious micrometers for measuring angles of all kinds in the heavens, have received the sanction of some of the most eminent practical astronomers in Europe, and are now considered as constituting an instrument of incalculable value for general astronomical observations. In this splendid telescope, made for the observatory of Dorpat, the hour-circle is divided by two verniers into four seconds of time, and the declination circle into ten seconds. The equatorial axis is put in motion by a clock having two sets of wheel-work, so that the telescope follows by itself the diurnal motion of the stars. But it may also be turned freely by the hand in every direction, or by means of an endless screw. The friction of the equatorial axis is diminished by friction rollers, so that the telescope, though its weight was about thirty-six quintals of Bavaria, could be moved by the pressure of a single finger. The object-glass is thirteen and one-third feet (Pied de Ro de Paris) in focal length, and its aperture is nine inches. It has eight astronomical eye-pieces, beside the following micrometers:—1. A repeating line micrometer, with a circle of position, whose two verniers give a single minute. This micrometer is furnished with a mechanism for illuminating the lines, the field remaining obscure, so that these lines appear to be luminous stripes on a dark ground. These lines are cut upon glass with a diamond point. As these lines appear like so many silver threads suspended in the heavens, the transits of the smallest stars across them may be observed. 2. Two micrometers, each of which consists of two free rings. 3. Two micrometers with one free ring. In all these micrometers, the rings, which are accurately turned out of brass, are fixed upon plates of glass, so that they seem to be suspended in the field of the telescope. By observing the immersions and emersions of the stars at the inner and outer circumferences of the rings, the differences of right ascension and declination of two stars are determined. 4. A micrometer of several concentric rings, which may be illuminated in the dark field. This micrometer has four eye-glasses. 5. An achromatic finder, of thirty inches in focal length, and twenty-nine of aperture. An instrument for correcting the axis of the great object-glass.—The price of the telescope now described is about 8000 Prussian dollars, or nearly £1300 sterling. The total weight of the whole package is thirty-eight quintals. An achromatic telescope with an object-glass eighteen feet in focal length, and with an aperture of twelve inches, and furnished with eye-glasses, micrometers, and parallactic stand, like the one now described, amounts to about £2720 sterling. Mr Fraunhofer engages likewise to construct these instruments with object-glass eighteen inches in diameter: and, as the price increases nearly as the cube of the diameter, an instrument of this kind will cost about £9200 sterling.

*Dollond's Achromatic Telescope.*—Fig. 5, No. 1, in the plate, represents the telescope, supported in the centre of gravity, with its rack-work motions, and mounted on its mahogany stand, the three legs of which are made to close up together by means of the brass frame *a a a*, which is composed of three bars connected together in the centre piece by three joints, and also to the three legs of the mahogany stand by three other joints, so that the three bars of this frame may lie close against the insides of the legs of the mahogany stand, when they are pressed together for convenience of carriage. The brass pin, under the rack-work, is made to move round in the brass socket *b*, and may be tightened by means of the finger-screw *d*, when the telescope is directed nearly to the object intended to be observed. This socket turns on two centres, by which means it may be set perpendicular to the horizon, or to any angle required in respect to the horizon; the angle may be ascertained by the divided arc, and then made fast by the screw *e*. If this socket be set to the latitude of the place at which the telescope is used, and the plane of this arc be turned on the top of the mahogany stand, so as to be in the plane of the meridian, the socket *b* being fixed to the inclination of the pole of the earth, the telescope, when turned in this socket, will have an equatorial motion, which is always very convenient in making astronomical observations.

No. 2, in the plate, represents a stand to be used on a table, which may be more convenient for many situations than the large mahogany stand. The telescope, with its rack-work, may be applied to either of the two stands, as occasion may require, the sockets on the top of both being made exactly of the same size. The sliding rods may be applied to the feet of the brass stand, so that the telescope may be used with the same advantages on one as on the other. The tube A A may be made either of brass or mahogany, of three and half feet long. The achromatic object-glass of three and half feet focal distance has an aperture of two inches and three quarters. The larger size is with a tube five feet long, and has an achromatic object-glass of three inches and one quarter aperture. The eye tube, as represented by B, contains four eye-glasses to be used for day, or any land, objects. There are three eye tubes, as C, which have two glasses in each to be used for astronomical purposes. These eye tubes all screw into the short brass tube at D. By turning the button or milled head at *f*, this tube is moved out of the larger so as to adjust the eye-glasses to the proper distance from the object-glass, to render the object distinct to any sight with any of the different eye tubes. The magnifying power of the three and half feet telescope with the eye tube for land objects is forty-five times, and of the five feet, for land objects, sixty-five times; with those for astronomical purposes, with the three and half feet the magnifying powers are eighty, one hundred and thirty, and one hundred and eighty; and for the five feet one hundred and ten, one hundred and ninety, and two hundred and fifty-times. Stained glasses, as *g*, are applied to all the different eye tubes, to guard the eye in observing the spots on the sun. These are to be taken off when the eye tubes are used for other purposes. The rack-work is intended to move the telescope in any direction required, and is worked by means of the two handles at *h*. When the direction of the tube is required to be considerably altered, the worm screws which act against the arc, and the circle must be discharged; then the screw *d*, being loosened, the pin of the rack-work will move easily round in the socket *d*.

For the more readily finding or directing the telescope to any object, particularly astronomical objects, there is a small tube or telescope, called the finder, fixed near the eye-end of the large telescope. At the focus of the object-glass of this finder there are two wires, which intersect each other in the axis of the tube, and as the magnifying power is only about six times, the real field of view is very large; therefore any object will be readily found within it, which being brought to the intersection of the wires, it will then be within the field of the telescope.—In viewing astronomical objects, (and particularly when the greatest magnifying powers are applied,) it is very necessary to render the telescope as steady as possible; for that purpose there are two sets of brass sliding rods, *i i*, as represented in the plate. These rods connect the eye-end of the telescope with two of the legs of the stand, by which any vibration of the tube, that might be occasioned by the motion of the air, or otherwise, will be prevented, and the telescope rendered sufficiently steady for using the greatest powers. These sliding rods move within one another, with so much ease as to admit of the rack-work being used in the same manner as if they were not applied.

*Herschel's* TELESCOPE.—This wonderful instrument was begun at Clayhill in 1785, and afterwards, with all its appatus, removed to Slough, near Windsor, where it was completed under the fostering patronage of royal munificence. The foundation on which the frame-work is erected, consists of two concentric circles of brickwork, so constructed, that the machinery may be turned so as to bring the point of the tube against any part of the heavens. The whole fabric is supported on twelve rollers, of which six are seen (I I I I) in the drawing. On each side of the elevated end of the tube is a double ladder, and at the opposite extremity is another. Several other smaller ones are seen in different parts, but their uses are too obvious to need either reference or description. The transverse beam H H, which is stretched horizontally over the crossings of the ladders, is bolted to them, and receives the hooks of different pulleys G G, as seen in the drawing. The ropes connected with these pulleys are moved by machinery, near the bottom. Below the mouth of the large tube is a gallery, C B, so constructed as to be elevated or depressed according to the situation of the tube. This furnishes gratification to the spectator, and enables the astronomer who views the heavens, to have access to the extremity of the tube whenever his presence may be required. The cabin D, of which the window is visible, affords shelter to those within, who, through the telescope, watch the motions of the heavenly bodies. The smaller cabin under the tube, is connected with the apparatus.—The tube of the telescope, which is 32 feet 4 inches long, and 4 feet 10 inches in diameter, is made entirely of iron, it having been ascertained that one of wood would exceed the iron one in weight by at least 3000 lb. The sheets were first put together by a kind of seaming that required no rivets, and when the sides of the iron platform were cut straight, it was lifted into a hollow gutter, and then brought gradually into a cylindrical form. Within the tube various hoops are fixed, some of which are connected by longitudinal bars of iron that are attached to the two ends of the tube. These are introduced, to brace the sheets, and keep the shape perfect, when the pulleys are applied to give the necessary elevation at the upper end, and that the speculum might be kept secure in its bed at the lower extremity. Its proportionate degrees of strength have been calculated with great care, so that at A no depression takes place. The lower end of the tube, which the cabin D renders invisible, is firmly supported on rollers that move forward or backward by the rackwork seen at E. The large speculum is enclosed in a strong iron ring, braced across with bars of iron, while an enclosure of iron and tin sheets makes a case for it. When necessity requires, it is lifted by three iron handles attached to the sides of the ring, and is taken from and returned to its place by a moveable crane that runs on a carriage. *See* OPTICS.

**TELESCOPIUM**, the *Telescope*, situated south of the Centaur Sagittarius, and contains nine small stars, one of which is of the fourth magnitude, the rest being less in size.

**TELESCOPIUM HERSCHELI.** Herschel's telescope is a new asterism, which has been inserted in honour of the astronomer of that name.—Boundaries and Contents: N. and E. by Lynx, E. and S, by the Twins, and W. by Auriga; right ascension 95°, declination 40° N. About 17 stars have been assigned to this constellation, from the 5th magnitude to the 8th.

**TELLER**, an officer of the exchequer, in ancient records called tallier; there are four of these officers, whose duty is to receive all sums due to the king, and to give the clerk of the pells a bill to charge him therewith.

**TELL-TALE**, on ship-board, a small piece of wood, traversing in a groove across the front of the poop deck, and which, by communicating with a small barrel on the axis of the steering wheel, indicates the situation of the helm.

**TEMPERATURE**, in general, denotes that degree of free caloric which a body appears to possess when compared with other bodies. Sir Humphrey Davy defines temperature to be " the power bodies possess of communicating or receiving heat, or the energy of repulsion." This definition, however, seems to have nothing but the celebrity of his name to recommend it.

**TEMPERING**, of steel and iron, the rendering of them either more compact and hard, or soft and pliant, according as the different uses for which they are wanted may require.

**TEMPLARS**, or TEMPLIERS, a religious order instituted at Jerusalem, about the year 1118. Some religious gentlemen put themselves under the government of the patriarch of Jerusalem, renounced property, made the vow of celibacy and obedience, and lived like canons regular. King Baldwin assigned them an apartment in his palace. They had likewise lands given them by the king, the patriarch, and the nobility, for their maintenance. They took the name of knights templars, because their first house stood near the temple dedicated to our Saviour at Jerusalem. This order having performed many great exploits against the infidels, became rich and powerful all over Europe; but the knights abusing their wealth and credit, fell into great disorders and irregularities. Many crimes and enormities being alleged against them, they were prosecuted in France, Italy, and Spain; and at last the pope, by his bull of the 22d of May, 1312, given in the council of Vienna, pronounced the extinction of the order of Templars, and united their estates to the order of St. John of Jerusalem.

**TEMPLE**, a public building erected in honour of some deity, either true or false, and in which people meet to pay religious worship to the same.

**TENACITY**, a term applied to metals, by which is meant the power that a metallic wire of a given diameter has of resisting, without breaking, the action of a weight suspended from its extremity.

**TENANT**, signifies one who holds or possesses lands or tenements by any kind of right, either in fee, for life, years, or at will.

**TENDER**, in Law, is an offer to pay a debt or perform a duty. This is is often pleaded in an action as a bar to the plaintiff's recovery; and where the money demanded by the plaintiff has been tendered or offered to him before the commencement of the suit, and he has refused to accept it, the plaintiff is barred of his action and costs.

**TENDER**, a small vessel employed to attend a larger one, to supply her with stores, to carry intelligence, &c. Vessels appointed to receive volunteers and impressed men, and to carry them to receiving ships, &c. are also called tenders.

**TENDING**, the movement by which a ship turns or swings round, when at single anchor, or moored by the head, in a tideway, at every change of tide.

**TENDONS**, are white, firm, and tenacious parts, continuous to the muscles, and usually forming their extremities.

**TENEMENT**, in its original, proper, and legal sense, signifies every thing that may be holden, provided it is of a permanent nature, whether it is of a substantial or unsubstantial and ideal kind.

TENNIS, a play at which a ball is driven by a racket.

TENON, in Building, &c. the square end of a piece of wood, or metal, diminished by one-third of its thickness, to be received into a hole in another place, called a mortise, for joining or fastening the two together.

TENSE, time, in Grammar, an inflection of verbs, whereby they are made to signify or distinguish the circumstance of time in what they affirm.

TENSION, the state of a thing stretched.

TENT, in Surgery, a roll of lint worked into the shape of a nail with a broad flat head.

TENTER, a railing used in cloth manufacture, to stretch out the pieces of cloth, stuff, &c. or only to make them even, and set them square. It is usually about four feet and a half high, and for length exceeds that of the longest piece of cloth. It consists of several long pieces of wood, placed so that the lower cross-piece of wood may be raised or lowered, as is found requisite, to be fixed at any height by means of pins. Along the pieces, both the upper and under one, are hooked nails, called tenter-hooks, driven in from space to space.

TENURE, the manner whereby lands or tenements are holden, or the service that the tenant owes to his lord.

TEREDO, in Natural History, the ship-worm, a genus of the vermes testacea class and order. There are three species. The shell of this worm is very thin, cylindrical, and smooth; found on the sides and bottoms of ships, and the stoutest oak pales which have remained some time under water: it was imported from India. The destruction which these worms effect under water is almost equal to that of the termes, or white ant, on land. The shell is more or less twisted, rather obtuse at the lip, and from four to six inches long. They will appear, on a very little consideration, to be the most important beings in the great chain of creation, and a pleasing demonstration of the infinitely wise and gracious power which formed and still preserves the whole in such wonderful order and beauty; for if it was not for the rapacity of these and such animals, tropical rivers, and indeed the ocean itself, would be choked with the bodies of trees annually carried down by the rapid torrents, as many of them would last for ages, and probably be productive of evils, of which happily we cannot in the present harmonious state of things form any idea; whereas now, being consumed by these animals, they are more easily broken in pieces by the waves; and the fragments which are devoured become specifically lighter, and are consequently more readily and more effectually thrown on shore, where the sun, wind, insects, and various other instruments, speedily promote their entire dissolution.

TERM, in Geometry, is the extreme of any magnitude, or that which bounds or limits its extent.

TERMS, are those spaces of time wherein the courts of justice are open for all that complain of wrongs or injuries, and seek their rights by course of law or action, in order to their redress; and during which the courts in Westminster hall sit and give judgments, &c. but the high court of parliament, the chancery, and inferior courts, do not observe the terms; only the court of King's Bench, Common Pleas, and Exchequer, the highest courts at common law. Of these terms there are four in every year: *viz.* Hilary term, which begins the 23d of January, and ends the 12th of February, unless on Sundays, and the day after; Easter term, which begins the Wednesday fortnight after Easter-day, and ends the Monday next after Ascension-day; Trinity term, which begins on the Friday after Trinity Sunday, and ends the Wednesday-fortnight after; and Michaelmas term, which begins the 6th and ends the 28th of November.

TERMS, *Irish*, are the same as those of London, except that at Michaelmas, which commences October 13, and adjourns to the beginning of November.

TERMS, *Oxford.* Hilary or Lent term begins on January 14, and ends on the Saturday before Palm Sunday. Easter term begins the tenth day after Easter, and ends the Thursday before Whit-Sunday. Trinity term begins the Wednesday after Trinity Sunday, and ends after the act, sooner or later, as the vice chancellor and convocation please. Michaelmas term begins on Oct. 10, and ends Dec. 17.

TERMS, *Cambridge.* Lent term begins on Jan. 13, and ends the Friday before Palm Sunday. Easter term begins the Wednesday after Easter week, and ends the week before Whit-Sunday. Trinity term begins the Wednesday after Trinity Sunday, and ends the Friday after the commencement. Michaelmas term begins Oct. 10, and ends Dec. 16.

TERMS *Scottish.* In Scotland, Candlemas term begins Jan. 23, and ends Feb. 12. Whitsuntide term begins May 25, and ends June 15. Lammas term begins July 30, and ends August 8. Martinmas term begins Nov. 3, and ends Nov. 21.

TERMES, or ANT, in Natural History, a genus of insects of the order aptera. The white ant is given in the Philosophical Transactions, of which we shall notice a few particulars. These insects are inhabitants of East India, Africa, and South America. They build pyramidal structures ten or twelve feet in height, and divided into appropriate apartments, magazines for provisions, arched chambers, and galleries of communication. These are so firmly cemented, that they easily bear four men to stand upon them, and in the plains of Senegal appear like the villages of the antives. With such wonderful dexterity and rapidity they destroy food, furniture, books, clothes, and timber of whatever magnitude, leaving a mere thin surface, that in a few hours a large beam will be eaten to a mere shell not thicker than writing paper. These only are the labourers who build the structures, procure provisions for the males and females, and take care of the eggs; they are the most numerous. Another class, called pupa, are larger, about half an inch long, with a very large ovate polished testaceous head. These never work, but act as superintendants over the labourers, or as guards to defend their habitations from intrusion and violence. When a breach is made in the dwelling, they rush forward, and defend the entrance with great ferocity; some of them beating with their mandibles against any hard substance, as a signal to the other guards, or as an encouragement to the labourers; they then retire, and are succeeded by the labourers, each with its burden of tempered mortar in its mouth; these diligently set about to repair whatever injury has been sustained. One of these attend every six or eight hundred labourers which are building a wall, taking no active part itself, but frequently making the noise above mentioned, which is constantly answered by a loud hiss from all the labourers, which at this signal evidently redouble their diligence.

TERRIER, a book or roll, wherein the several lands, either of a private person, or of a town, college, church, &c. are described. It should contain the number of acres, and the site, boundaries, tenants' names, &c. of each piece or parcel.

TESSELLATED PAVEMENTS, those of rich mosiac work, made of curious square marbles, bricks, or tiles, called tesselæ from their resembling dice.

TEST *Act.* A statute 25 Car. II. cap. 2, which requires all officers, both civil and military, to take the oaths and test, *viz.* the sacrament, according to the rights and ceremonies of the church of England. Various ineffectual attempts have been made by the Dissenters to obtain the repeal of this act, which is evidently offensive to the genuine principles of civil and religious liberty.

TESTACEA, in the Linnæan system of natural history, the third order of vermes. This order comprehends all shell-fish, arranged by Linnæus under thirty-six genera. Shell-fish are animals with a short body, covered by or enclosed in a firm, hard, and stony habitation, composed according to their three separate orders.

TESTAMENT, in Law, a solemn and authentic act, whereby a person declares his will, as to the disposal of his estate, effects, burial, &c.

TESTUDO, the *Tortoise*, in Natural History, a genus of amphibia, of the order reptiles. These animals feed on sea-weeds or on worms, are extremely prolific; but in the state of eggs, and while very young, are the prey of various animals. Their movements are slow; they are capable of being tamed, and will in that state eat almost any thing presented to them. They exist long in such air as would be destructive to other animals of the same size, and have such tenaciousness of life, that it is stated that they will exhibit convulsive movements for several days after their bodies have been opened, and even after their heads have been cut off. In cold latitudes the land tortoise is torpid during the winter. There are thirty-five species, of which we shall notice the following.—The common tortoise. The weight of this animal is three pounds, and the length of its shell about seven inches. It abounds in the countries surrounding the Mediterranean, and particularly in Greece, where the inhabitants not only eat its flesh and eggs, but frequently swallow its warm blood. In September or October it conceals itself, remaining torpid till February, when it re-appears. In June it lays its eggs in holes exposed to the full beams of the sun, by which they are matured. The males will frequently engage in severe conflicts, and strike their head against each other with great violence, and very loud sounds. Tortoises attain most extraordinary longevity, and one was ascertained to have lived in the gardens of Lambeth to the age of nearly one hundred and twenty years. Its shell is preserved in the archiepiscopal palace. So reluctant is the vital principle to quit these animals, that Shaw informs us from Redi, one of them lived for six months after all its brains were taken out, moving its limbs and walking as before. Another lived twenty-three days after its head was cut off, and the head itself opened and closed its jaws for a quarter of an hour after its separation from the body. It may not only be tamed, but has in several instances exhibited proof in that state of considerable sagacity, in distinguishing its benefactors, and of grateful attachment in return for their kindness, notwithstanding its general sluggishness and torpor. It will answer the purpose of a barometer, and uniformly indicates the fall of rain before night, when it takes its food with great rapidity, and walks with a sort of mincing and elate step. It appears to dislike rain with extreme aversion, and is discomfited and driven back only by a few and scarcely perceivable drops.—The mud tortoise, is common both in Europe and Asia, and particularly in France, where it is much used for food. It is seven inches long; lays its eggs on the ground, though an aquatic animal; walks quicker than the land tortoise; and is often kept in gardens, to clear them from snails and various wingless insects. In fish-ponds it is very destructive, biting the fishes, and, when they are exhausted by the loss of blood, dragging them to the bottom and devouring them.—The fierce tortoise, is found in several parts of North America, and is eighteen inches long. It is rapid and vigorous in its movements, and will spring on its enemy with great elasticity and violence. Its flesh is thought extremely good. It is found in the muddy parts of rivers, concealing itself among the weeds. It will also dart with great celerity on birds.—The sea tortoises, or turtles, are distinguished from the former, by having very large and long feet in the shape of fins, the claws of some of the toes not being visible but enclosed. The common green turtle is not unfrequently five feet long, and of the weight of 500 pounds; and is denominated green from the shade of that colour assumed by the fat, when the animal is in its perfect state. In the West Indies it has been long in the highest estimation for the table, and within sixty or seventy years it has gradually been advancing in reputation in this country, for food, and is at present considered as furnishing the highest gratification of epicurism. It is imported into England in vast numbers. It feeds on sea grass, called turtle grass. It is taken sometimes after being watched to its haunts; and being thrown on its back, is unable to rise again on its feet: sometimes it is struck in the water with a long staff armed with iron at the end. The markets of the West Indies are supplied with the flesh of these animals, as those of Europe are with mutton and beef; and before they were much sought as articles for exportation, forty sloops were employed by the inhabitants of Port Royal in catching them. They are seldom seen on land but at the season of laying their eggs, which they do at several times, after intervals of fourteen days. They are occasionally found, probably in consequence of tempests, on the coasts of Europe. The imbricated turtle, or hawksbill, is so called from its shells lapping one over another, like tiles on the roof of a house. It is about three feet long; is found in the seas both of Asia and America, and sometimes also in the Mediterranean; and is said to have been seen even of 600 pounds weight. Its flesh is of no estimation; but its lamina are manufactured into the elegant material known by the name of tortoise-shell, which has been applied by human ingenuity to innumerable purposes both of use and ornament. The thickness of the plate varies in reference to the age and size of the turtle. Those of a very young one are of no value. A large one will supply ten pounds' weight of valuable scales, which being softened by heat, and lapped over each other by means of pressure, become effectually united, so as to constitute one piece of considerable extent, and without any perceivable trace of their separation. This article was well known to the Greeks and Romans, and was an important materal of luxury and commerce. Various articles of furniture, and even beds, were inlaid with it. The Egyptians exported large cargoes of it to Rome for these purposes, and in China, as well as Europe, it is at present in very high demand for elegant and ornamental manufactures.

Testudo, in the Military Art of the ancients, was a kind of cover or screen which the soldiers, *e.gr.* a whole company, made themselves of their bucklers, by holding them up over their heads, and standing close to each other. This expedient served to shelter them from darts, stones, &c. thrown upon them, especially those thrown from above, when they went to the assault.

Testudo, was also a kind of large wooden tower which moved on several wheels, and was covered with bullocks' hides, serving to shelter the soldiers when they approached the walls to mine them, or to batter them with rams.

**TETANUS**, in Surgery, a locked jaw.

**TETRAEDRON**, or Tetrahedron, in Geometry, is one of the five Platonic or regular bodies or solids, comprehended under four equilateral and equal triangles. Or, it is a triangular pyramid of four equal and equilateral faces.

**TETRAGON**, in Geometry, a quadrangle, or a figure with four angles.

**TETRANDRIA**, the fourth class in Linnæus's sexual system.

**TETRAO**, in Natural History, a genus of birds of the order gallinæ. Birds of this genus, which according to Gmelin comprehends the grouse, the partridge, and the quail, follow the dam immediately on being hatched, and before the shell is wholly detached from them; their bill is strong and convex, and their flesh and eggs form an exquisite repast. There are seventy-three species, of which the following are best deserving of notice.—The cock of the wood, is of the size of a turkey, and is found from Russia to Italy, preferring the elevated and mountainous parts of temperate countries, as it delights in a cold temperature. Its eggs are deposited on moss, and whenever left by the female, which is unassisted in the process of incubation, are covered over with leaves. The males and females live separate, except during the months of February and March. Their food consists of various plants and grains, and buds of trees. The seeds of the pine and fir they are particularly fond of.—The black grouse, is larger than a common fowl, and abounds in the British islands, particularly in the northern districts. The birds of this species, and of the last, do not pair like other birds, and the male is generally seen with several females in his train, They subsist on seeds and herbage, and are particularly fond of the seeds of the birch and Siberian poplar.—The ptarmigan grouse, is fourteen inches long, and inhabits the north of Europe. It is not uncommon in the Highlands and the Hebrides, and is sometimes found in Cumberland. These birds subsist on seeds, fruits, and berries, and are silly and inadvertent to danger.—The common partridge, is thirteen inches long, and abounds in the temperate regions of Europe; it is unable to sustain rigorous cold or intense heat. *See* Quail.

**TETRAPLA**, a Bible disposed by Origen under four columns, in each of which was a different Greek version, namely, that of Symmachus, of Aquila, of the Seventy, and of Theodotian.

**TEUTONIC ORDER**, a military order of knights, established towards the close of the twelfth century, and thus called as consisting chiefly of Germans or Teutons. The origin, &c. of the Teutonic order is said to be this; the Christians under Guy of Lusignan, laying siege to Acre, a city of Syria, on the borders of the Holy Land, some Germans of Bremen and Lubeck, touched with compassion for the sick and wounded of the army, who wanted common necessaries, set on foot a kind of hospital under a tent, which they made of a ship's sail, and here betook themselves to a charitable attendance on them. This excited a thought of establishing a third military order, in imitation of the Templars and Hospitallers. The design was approved of by the patriarch of Jerusalem, the archbishop and bishops of the neighbouring places, the king of Jerusalem, the masters of the temple and hospital, and the German lords and prelates then in the Holy Land, and Pope Calixtus III. confirmed it by his bull, and the new order was called the Order of Teutonic Knights of the House of St. Mary at Jerusalem. The pope granted them all the privileges of the Templars and Hospitallers of St. John, excepting that they were to be subject to the patriarchs and other prelates, and that they should pay tithes of what they possessed.

TEXT, a relative term, contradistinguished to gloss or commentary, and signifying an original discourse, exclusive of any note or interpretation. This word is particularly used for a certain passage of scripture chosen by a preacher to be the subject of a sermon.

THALLITE, a stone found in the fissures of mountains in Dauphiny, and on Chamouni in the Alps. It is sometimes amorphous, and sometimes crystallized.

THATCH, prepared straw or reed, laid on the top of ricks, stacks, or houses, to keep out the wet.

THEATRE, a public edifice for the exhibition of scenic spectacles and shows, to amuse the people, and also a place for dramatic representations. In Surgery, it is the room in which anatomical dissections are carried on.

THEFT, in Law, an unlawful felonious taking away another man's moveable and personal goods, against the owner's will, with intent to steal them. It is divided into theft or larceny, properly so called, and petit theft, or petit larceny; the former whereof is of goods above the value of 12*d.* and is deemed felony; the other, which is of goods under that value, is not felony.

THEFTBOTE, the receiving a man's goods again from a thief, or other amends by way of composition, and to prevent prosecution, that the felon may escape unpunished; the punishment whereof is fine and imprisonment.

THEME, a subject or topic on which to write or compose.

THEODOLITE, a mathematical instrument much used in surveying, for the taking of angles, distances, &c.

THEOGONY, the science which treats of the primitive, chaotic, or elementary state of things.

THEOLOGY, the science which instructs mankind in the knowledge of God and divine things; or that which has God, and what he has revealed, for its object.

THEOREM, a proposition which terminates in theory, and which considers the properties of things already made or done. Or, theorem is a speculative proposition deduced from several definitions compared together.

THEORY, a doctrine which terminates in speculation, without any view to the practice or application of it.

THERMOMETER, an instrument for ascertaining the temperature, that is, for measuring the degree of heat or cold, in any body. The thermometer was invented about the beginning of the 15th century; but, like many other useful inventions, it has been found impossible to ascertain to whom the honour of it belongs. Fahrenheit's thermometer consists of a slender cylindrical tube, and a small longitudinal bulb. To the side of the tube is annexed a scale, which Fahrenheit divided into 600 parts, beginning with that of the severe cold which he had observed in Iceland in 1709, or that produced by surrounding the bulb of the thermometer with a mixture of snow or beaten ice, and sal ammoniac or sea salt. This he apprehended to be the greatest degree of cold, and accordingly he marked it, as the beginning of his scale, with 0; the point at which mercury begins to boil, he conceived to shew the greatest degree of heat, and this he made the limit of his scale. The distance between these two points he divided into 600 equal parts or degrees; and by trials he found that the mercury stood at 32 of these divisions when water just begins to freeze, or snow or ice just begins to thaw; it was therefore called the degree of the freezing point. When the tube was immersed in boiling water, the mercury rose to 212, which therefore is the boiling point, and is just 180 degrees above the former, or freezing point. But the present method of making the scale of these thermometers, which is the sort in most common use, is first to immerge the bulb of the thermometer in ice or snow just beginning to thaw, and mark with 32 the place where the mercury stands; then immerge it in boiling water, and again mark the place where the mercury stands in the tube with the number 212, exceeding the former by 180; dividing therefore the intermediate space into 180 equal parts, will give the scale of the thermometer; whic may afterwards be continued upwards and downwards at plea sure. Other thermometers of a similar construction have beei accommodated to common use, having but a portion of th above scale. They have been made of a small size and portabl form, and adapted with appendages to particular purposes and the tube, with its annexed scale, has often been enclosed i another thicker glass tube, also hermetically sealed, to preserve the thermometer from injury. And all these are called *Fahrenheit's thermometers.*

The thermometer at present used in France is called *Reaumur's*; but it is very different from the one originally invented by Reaumur in 1730, and described in the Memoirs of the Academy of Sciences. The one invented by Reaumur was filled with spirit of wine; and though its scale was divided by the author into 80 parts, of which 0 was the freezing point, and 80 the boiling-water point, yet in fact 80 was only the boiling point of the spirit of wine that he employed, which, as Dr. Martine computes, corresponded with 180 of Fahrenheit. But the thermometer now in use in France is filled with mercury; and the boiling-water point, which is at 80, corresponds with the 212th degree of Fahrenheit. The scale indeed commences at the freezing point, as the old one did. The new thermometer ought more properly to be called *De Luc's thermometer*, for it was first made by De Luc; and is in fact as different from Reaumur's as it is from Sir Isaac Newton's. When De Luc had fixed the scale, and finished an account of it, he shewed the manuscript to M. De la Condamine. Condamine advised him to change the number 80; remarking, that such was the inattention of philosophers, that they would probably confound it with Reaumur's. De Luc's modesty, as well as a predilection for the number 80, founded as he thought on philosophical reasons, made him decline following this advice. But he found by experience that the prediction of Condamine was too well founded. The thermometer of Celsius, which is used in Sweden, has a scale of 100 degrees from the freezing to the boiling-water point. This is, in fact, the *centigrade* thermometer. These are the principal thermometers now used in Europe; and the temperature indicated by any of them may be reduced into the corresponding degrees on any of the others, by means of the following simple theorems; in which R signifies the degrees on the scale of Reaumur, F those of Fahrenheit, and S those of the Swedish thermometer.

1. To convert the degrees of Reaumur into those of Fahrenheit; $\frac{R \times 9}{4} + 32 = F$. 2. To convert the degrees of Fahrenheit to those of Reaumur; $\frac{(F - 32) \times 4}{9} = R$. 3. To convert the Swedish degrees into those of Fahrenheit; $\frac{S \times 9}{5} + 32 = F$. 4. To convert Fahrenheit's into Swedish; $\frac{(F - 32) \times 5}{9} = S$. 5. To convert Swedish degrees into those of Reaumur; $\frac{S \times 4}{5} = R$. 6. To convert Reaumur's degrees into Swedish; $\frac{R \times 5}{4} = R$.

To such readers as are unacquainted with the algebraic expression of arithmetical formulæ, it will be sufficient to express one or two of these in words, to explain their use;—1. Multiply the degree of Reaumur by 9, divide the product by 4, and to the quotient add 32; the sum expresses the degree on the scale of Fahrenheit. 2. From the degree of Fahrenheit subtract 32, multiply the remainder by 4, and divide the product by 9, the quotient is the degree according to the scale of Reaumur, &c.—As in meteorological observations it is necessary to attend to the greatest rise and fall of the thermometer, attempts have been made to construct a thermometer which might register the greatest degree of heat, or greatest degree of cold, which took place during the absence of the observer.—The following is properly a spirit thermometer, though mercury is employed in it for the purpose of supporting a certain index; *ab*

Fig. 1.

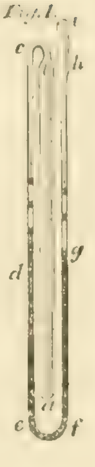
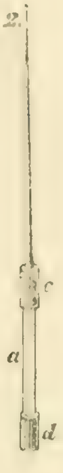


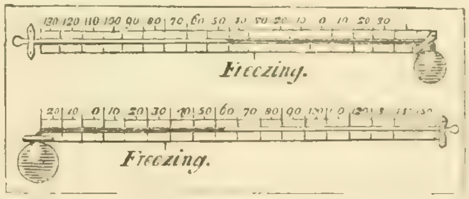
Fig. 2.



(fig. 1, is) a tube of thin glass, about sixteen inches long, and $\frac{3}{16}$ of an inch in diameter; *c d e f g h* is a smaller tube, with the inner diameter about $\frac{1}{30}$th joined to a larger at the upper end *b*, and bent down first on the left side, and then, after descending two inches below *a b*, upwards again on the right, in the several directions *c d e, f g h*, parallel to, and one inch distant from it. At the end of the same tube, at *h*, the inner diameter is enlarged to half an inch from *h* to *i*, which is two inches in length. This glass is filled with highly rectified spirit of wine to within half an inch of the end *i*, excepting that part of the small tube from *d* to *g* which is filled with mercury. From a view of the instrument, it will be readily conceived that when the spirit in the large tube is expanded by heat, the mercury in the small tube on the left side will be pressed down, and cause that on the right side to rise; on the contrary, when the spirit is condensed by cold, the reverse will happen. Fahrenheit's scale, which begins with 0 at the top of the left side, has the degrees numbered downwards, while that at the right side, beginning with 0 at the bottom, ascends. The divisions are ascertained by placing the thermometer with a good standard mercurial one in water, gradually heating or cooling, and marking the divisions of the new scale at every five degrees. The divisions below the freezing point are taken by means of a mixture of sea-salt and ice, as described by Nollet, De Luc, and others. In order to shew how high the mercury has risen in the observer's absence, there is placed within the small tube of the thermometer, above the surface of the mercury on either side, immersed in the spirit of wine, a small index, so fitted as to pass up and down as occasion may require. One of these indices is represented in fig. 2; *a* is a small glass tube, three-quarters of an inch long, hermetically sealed at each end, enclosing a piece of steel wire nearly of the same length; at each end, *c d*, is fixed a short piece of a tube of black glass, of such a diameter as to pass freely up and down within the small tube of the thermometer. The lower end floating on the surface of the mercury, is carried up with it when it rises, while the piece at the upper end, being of the same diameter, keeps the body of the index parallel to the sides of the thermometrical tube. From the upper end of the body of the index at *c* is drawn a spring of glass to the fineness of a hair, about four-fifths of an inch in length, which being set a little oblique, presses lightly against the surface of the tube, and prevents the index from following the mercury when it descends, or being moved by the spirit passing up and down, or by any sudden motion given to the instrument; but at the same time the pressure is so adjusted as to permit this index to be readily carried up by the surface of the rising mercury, and downwards whenever the instrument is rectified for observation. The index, by not returning with the mercury when it descends, shews distinctly and accurately how high the mercury has risen, and consequently what degree of cold or heat has happened. To prevent the spirit from evaporating, the tube at the end *i* is closely sealed. The daily rectification of this instrument is performed by applying a small magnet to that part of the tube against which the index rests; by the action of which the included piece of steel wire, and consequently the index, is easily brought down to the surface of the mercury. When this has been done, the instrument is rectified for the next day's observation, without heating, cooling, separating, or at all disturbing the mercury, or moving the instrument. With a thermometer of this sort, Mr. Six observed the greatest degree of heat and cold that happened every day and night throughout the year 1781.

In 1790 two thermometers were invented by Dr. John Rutherford; the one for registering the highest, and the other for registering the lowest degree of heat to which the thermometer has risen or fallen during the absence of the observer. A new self-registering thermometer has more recently been invented by Mr. Keith, of Ravelstone, which Dr. Gregory considers as the most ingenious, simple, and perfect, of any which has hitherto appeared. Its simplicity is so great, that it requires only a very short description to make it intelligible. It is constituted first of a thin glass tube about fourteen inches long, and 3-4ths of an inch caliber, close or hermetically sealed at top. To the lower end, which is open, there is joined a crooked glass tube seven inches long, and 4-10ths of an inch caliber, and open at its top, which, of course, is level with the middle of the first tube. The former tube is filled with the strongest spirit of wine, and the latter tube with mercury. This is properly a spirit-of-wine thermometer, and the mercury is used merely to support a piece of ivory or glass, for which is affixed a wire for raising one index or depressing another, according as the mercury rises or falls. There is a small conical piece of ivory or glass, of such a weight as to float on the surface of the mercury. To the float is joined a wire called the *float wire*, which reaches upwards, where it terminates in a knee bent at right angles. The float-wire, by means of an eye fixed at its extremity, moves easily along a small vertical harpsichord wire. There are two indexes made of thin black oiled silk, which slide upwards or downwards with a force not more than two grains. The one placed above the knee points out the greatest rise, and the one placed below it points out the greatest fall, of the thermometer.

When the instrument is to be prepared for an observation, both indexes are to be brought close to the knee. It is evident, that when the mercury rises, the float and float-wire, which can be moved with the smallest force, will be pushed upwards till the mercury becomes stationary. As the knee of the float-wire moves upwards, it will carry along with it the upper index. When the mercury again subsides, it leaves the index at the point to which it was raised, for it will not descend by its own weight; as the mercury falls, the float-wire does the same; it therefore brings along with it the lower index, and continues to depress it till it again becomes stationary, or ascends in the tube, in which case it leaves the lower index behind it, as it had formerly left the upper. The scale to which the indexes point is placed parallel to the slender harpsichord wire. That the scale and indexes may not be injured by the wind and rain, a cylindrical glass cover, close at top, and made so as exactly to fit, is placed over it. The ingenious inventor has another improvement, which if upon trial it be found to answer, will make this thermometer as perfect as can be desired, provided there do not arise some errors from the variable pressure of the atmosphere. He proposes to adapt clock-work to this thermometer, in such a way as to register with the utmost precision the degrees of heat and cold for every month, day, and minute, in the year. An account of this latter improvement may be seen in Nicholson's Journal, vol. iii. 4to. series, or Edin. Trans. vol. iv.



The common contrivance for a self-registering thermometer, now sold in most of the London shops, consists simply of two thermometers, one mercurial and the other of alcohol, having their stems horizontal, as in the annexed figure: the former has for its index a small bit of magnetical steel wire, and the latter a minute thread of glass, having its two ends formed into small knobs by fusion in the flame of a candle.

The magnetical bit of wire lies in the vacant space of the mercurial thermometer, and is pushed forward by the mercury whenever the temperature rises, and pushes that fluid against it; but when the temperature falls and the fluid retires, this index is left behind, and consequently shews the maximum. The other index, or bit of glass, lies in the tube of the spirit thermometer immersed in the alcohol, and when the spirit retires by depression of temperature, the index is carried along with it in apparent contact with its interior surface; but on increase of temperature the spirit goes forward, and leaves the index, which therefore shews the minimum of temperature since it 'was set. As these indexes merely lie in the tubes, their resistance to motion is altogether inconsiderable. The steel index is brought to the mercury by applying a magnet on the outside of the tube, and the other is duly placed at the end of the column of alcohol by inclining the whole instrument. When the surface of the column of spirit is viewed by a magnifier, it is seen to have the form of a concave hemisphere, which shews that the liquid is attracted by the glass. The glass in that place is consequently attracted in the opposite direction by a force equal to that which is so employed in maintaining that concave figure; and if it were at liberty to move, it would be drawn back till the flat surface was restored. Let us suppose a small stick or piece of glass to be loose within the tube, and to protrude into the vacant space beyond the surface of the alcohol. The fluid will be attracted also by this glass, and form a concave between its surface and that of the bore of the tube. But the small interior piece being quite at liberty to move, will be drawn toward the spirit so long as the attractive force possesses any activity; that is, so long as any additional fluid hangs round the glass; or, in other words, until the end of the stick of glass is even with the surface. Whence it is seen that the small piece of glass will be resisted, in any action that may tend to protrude it beyond the surface of the fluid; and if this resistance be greater than the force required to slide it along in the tube (as in fact it is,) the piece must be slided along as the alcohol contracts; so as always to keep the piece within the fluid. And this fact is accordingly observed to take place.

Professor Leslie, well known for his genius, has invented a differential thermometer, for the measurement of minute variations of temperature. It consists of two tubes, each terminating in a small bulb of the same dimensions, joined by the blowpipe, and bent in the form of a U, a small portion of dark coloured liquor having previously been introduced into one of the balls. After many trials, the fluid best adapted to the purpose was found to be a solution of carmine in concentrated sulphuric acid. By managing the included air with the heat of the hand, this red liquor is made to stand at the required point of the opposite tube. This is the zero of a scale fastened to that tube, and divided into equal parts above and below that point. The instrument is then fixed on a stand. It is manifest, that when the liquor is at rest, or points at zero, the column is pressed in opposite directions by two portions of air equal in elasticity, and containing equal quantities of caloric. Whatever heat, then, may be applied to the whole instrument, provided both bulbs receive it in the same degree, the liquor must remain at rest. But if the one ball receives the slightest excess of temperature, the air which it contains will be proportionally expanded, and will push the liquid against the air in the other bulb with a force varying as the difference between the temperatures of those two portions of air; thus the equilibrium will be destroyed, and the fluid will rise in the opposite tube. The degrees of the scale through which it passes will mark the successive augmentations in the temperature of the ball which is exposed to the greatest heat. So that this instrument is a balance of extreme delicacy for comparing the temperature of its two scales.

It is a small variation from this thermometer that constitutes Mr. Leslie's Photometer. When thermometers are devised to measure very great degrees of heat, they are usually called by another name. *See* Pyrometer. The thermometer and barometer together are very useful in determining the altitudes of mountains, &c. For this purpose they are fixed in such a frame as to be conveniently portable. *See* Barometer.

THICK Stuff, planks thicker than those commonly used, which are placed opposite to the several scarfs or joinings in the frame of timbers.

THIMBLE, a covering for the finger, made of any metal, to protect it from the needle, in use among tailors, milliners, and all who are accustomed to sew.

THIMBLE, in the language of ship-riggers, is a sort of iron ring, whose outer surface is hollowed throughout its whole circumference, in order to contain in the channel or cavity a rope which is spliced about it, and by which it may be hung in any particular situation. Its use is to defend the eye of the rope which surrounds it, from being injured by another rope which passes through it, or by the hook of a tackle which is hung upon it.

THINKING, in general, any act or operation of the mind, but its physical principles are concealed from the eye of human penetration.

THISTLE, Order of the, or of St. Andrew a military order of knighthood in Scotland.

Thistle, in Agriculture, a well-known prickly weed, common in cornfields. Of this troublesome plant there are various kinds. They indicate strong land, but require the watchful care of the farmer.

THOLES, *i.e.* bearers or fulcra, are small pins driven perpendicularly into the gunwale of a boat, and serving to retain the oars in that space which is called the row-lock; sometimes there is only one pin to each oar, as in the boats navigated in the Mediterranean sea. In that case, the oar is retained upon the pin by means of a strop, or of a cleat, with a hole through it, nailed on the side of the oar.

THOR, in Mythology, an ancient deity, worshipped among the northern nations, from whom our Thursday derives its name.

THORACIC, or Thoracici, a term applied to an order of fishes in the Linnæan system: the character of this order is, that they have bony gills, and ventral fins directly under the thorax.

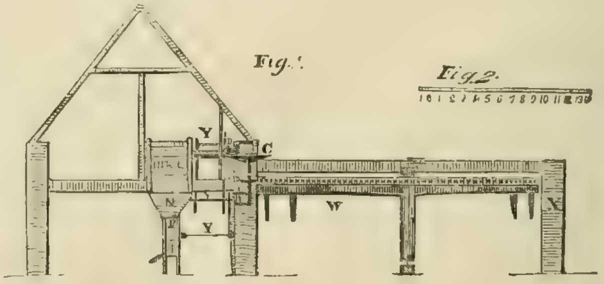
THORINA. An earth discovered in 1816 by M. Berzelius, in small quantities, in the gadolinite of Korarvet. It resembles zirconia.

THORN, in Botany, a name given to all trees and shrubs of the larger kind, which are armed with spikes or prickles.

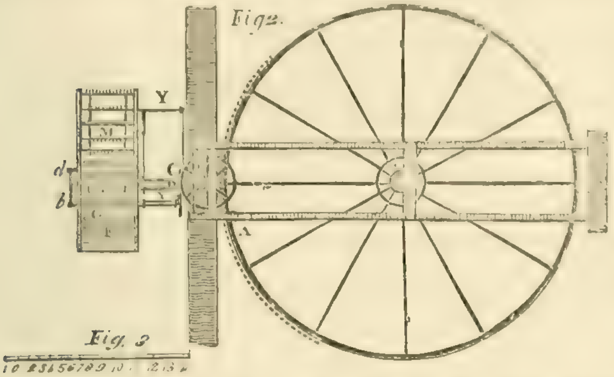
THOUGHT, a general name for all the ideas consequent on the operations of the mind, and even for the operations themselves.

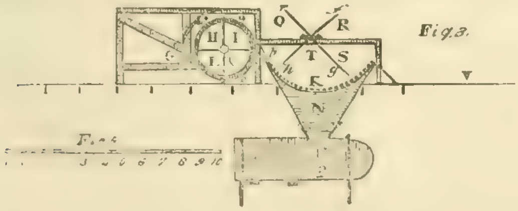
THRASHING, or Threshing, in Agriculture, the act of beating the corn out of the ears. There are several ways of separating corn from the ears; the first by beating it with a flail, which is properly what is called thrashing. The other method, still practised in several countries, is to make mules or horses trample on it backwards and forwards; this is properly what the ancients called tritura and trituratio. The Hebrews used oxen therein, and sometimes yoked four together for this purpose. Another way among the ancients was with a kind of sledge made of boards joined together and loaded with stone or iron, upon which a man was mounted, and the whole drawn over the corn by horses; this instrument was called traba or tribula. It is a rule among husbandmen, that the season for thrashing is as soon as the corn has sweated in the heap or mow.

THRASHING MACHINES, were first constructed in Britain about the year 1732; and various improvements took place till the invention of Mr. Andrew Meikle in 1785, who obtained a patent which has since expired: fig. 1, represents the plan of elevation; fig. 2, the ground plan; and fig. 3, the essential parts of the machinery, so as to convey a tolerably accurate idea of his principle. A, fig. 1, and 2, is a large horizontal spur-wheel, which has 276 cogs, and moves the pinion B, having fourteen teeth. The latter imparts motion to a crown-wheel C, that is provided with eighty-four cogs, and moves a second pinion, D, which is furnished with sixteen teeth. This pinion D, turns the drum H I K L, fig. 1, 2, and 3, being a hollow cylinder, three feet and a half in diameter, and placed horizontally: on its outside are fixed, by means of screw bolts, four scutchers, or pieces of



wood, one side of which is faced with a thin iron plate: and which are disposed at an equal distance from each other, and at right angles to the axis of the drum. P, fig. 2, and 3, is an inclined board, on which the sheaves are spread, and whence they are introduced between two fluted cast-iron rollers, G, G, fig. 3, that are three and a half inches in diameter, and revolve about thirty-five times in one minute. These rollers being only three-fourths of an inch from the scutchers or leaves of the drum H I K L, fig. 1, and 2, serve to keep the sheaves steady while the scutchers *a*, *b*, *c*, *d*, fig. 2, and 3, move with considerable velocity, and thus separate the grain from the straw, while both are thrown on the concave rack M, fig. 2, which lies horizontally with slender parallel ribs; so that the corn may pass through them into the subjacent hopper N, fig. 1, and 3. O, fig. 3, is a riddle or harp, through which the corn drops into a pair of fanners, P, fig. 1 and 3, and from these it is generally obtained in a state fit for the market. Q R T S, is a rake consisting of four leaves, or thin pieces of wood; at the extremity of each is placed a row of teeth, *e*, *f*, *g*, *h*, that are five inches long. This rake moves in the concave rack M, fig. 2, in a circular direction; while the teeth catch the straw that had been thrown by the scutchers *a*, *b*, *c*, *d*, into the rack, and remove it to the contiguous place V. W, fig. 1, represents the horse's course, which is 27 feet in diameter. X, fig. 1 and 2, is the figure for supporting the beams on which the axle of the spur-wheel is fixed. Y, Y, Y, fig. 1, and Y, Y, fig. 2, shew the spindles, the design of which is to move the two fluted rollers, the rake, and the fanners.





To the description now given we have only to add, that the drum has a covering of wood at a small distance above it, for the purpose of keeping the sheaves close to the scutchers. The number of persons requisite for attending the mill when working is six: one person drives the horses; a second hands the sheaves to a third, who unties them; while a fourth spreads them on the inclined boards, and presses them gently between the rollers; a fifth person is necessary to riddle the corn as it falls from the fanners, and a sixth to remove the straw. This machine can be moved equally well by water, wind, or horses. Mr. Meikle has made such improvements on the windmill as to render it much more manageable and convenient than formerly; and we are informed many such windmills are erected in different parts of the country. As to the comparative expense of these different machines, the erection of the horse-machine is least; but then the expense of employing horses must be taken into consideration. One of this kind may be erected for 70*l.* A water-mill will cost 10*l.* more, on account of the expense of the water-wheel. A windmill will cost from 200*l.* to 300*l.* sterling. In thrashing machines, however, cheapness should not be the only consideration. It often happens in machinery that things apparently cheap are ultimately very dear. Thrashing of corn requires a strong power, to which neither weak men nor slight machines are competent. On this account strong and durable machines are to be recommended as cheapest in the end; performing more work, in a better manner, and not needing frequent repairs. Some other well-constructed thrashing-machines are described in Gray's Experienced Millwright, Bailey's Descriptions of Machines approved by the Society of Arts, in the Repertory of Arts and Manufactures, the 2d vol. of Dr. Brewster's Ferguson, and the 11th vol. of the Pantologia. With respect to the quantity of corn which a machine will thrash in a given time, it is not easy to give any precise information; the most important we have yet met with is given by Mr. Fenwick who found from numerous experiments that a power capable of raising a weight of 1000 pounds with a uniform velocity of fifteen feet per minute, will thrash two bolls (eight bushels) of wheat in an hour; and that a power sufficient to raise the same weight with a velocity of twenty-two feet per minute, will thrash three bolls of the same grain in an hour. From these facts, this gentleman has computed the following table, which is applicable to machines that are driven either by water or horses.

| Gallons of water per minute, ale measure, discharged on an overshot wheel 10 feet in diameter. | Gallons of water per minute, ale measure, discharged on an overshot wheel 15 feet in diameter. | Gallons of water per minute, ale measure, discharged on an overshot wheel 20 feet in diameter. | Number of horses working 9 hours and a half | Bolls of wheat thrashed in an hour. | Bolls thrashed in 9 hours and a half, or a natural working day, or in a day |
|---|---|---|---|---|---|
| 230 | 160 | 130 | 1 | 2 | 19 |
| 390 | 296 | 205 | 2 | 3 | 28½ |
| 528 | 380 | 272 | 3 | 5 | 47½ |
| 660 | 470 | 340 | 4 | 7 | 66½ |
| 790 | 565 | 400 | 5 | 9 | 85½ |
| 970 | 680 | 500 | 6 | 10 | 95 |
| 1 | 2 | 3 | 4 | 5 | 6 |

The first four columns of the preceding table contain different quantities of impelling power, and the last two exhibit the number of bolls of wheat in Winchester measure, which such powers are capable of thrashing in an hour, or in a day. Six horses, for example, are capable of thrashing ten bolls of wheat in an hour, or ninety-five in the space of nine hours and a half, or a working day; and 680 gallons of water discharged into the buckets of an overshot water-wheel of 15 feet diameter during a minute, will thrash the same quantity of grain.

**THRAVE**, or **THREAVE OF CORN**, twenty-four sheaves, or four shocks of six sheaves to the shock, though in some counties they only reckon twelve shocks to the thrave.

**THREAD**, a small line made up of a number of fine fibres of any vegetable or animal substance, such as flax, cotton, or silk; from which it takes its name of linen, cotton, or silk thread.

**THREATENING LETTER.** If any person shall send any letter threatening to accuse any person of a crime punishable with death, transportation, pillory, or other infamous punishment, with a view to extort money from him, he shall be punished at the discretion of the court with fine, imprisonment, pillory, whipping, or transportation.

**THROAT**, among Seamen, is a name given to that end of a gaff which is next the mast, and is opposed to peek, which implies the outer end: hence, *Throat Brails*, are those which are attached to the gaff close to the mast. *Throat Halliards*, ropes or tackles applied to hoist the inner part of the gaff, and its appendent portion of the sail.

**THRUM**, (To,) a phrase at sea, which signifies to insert in a sail or mat, &c. through small holes made by a bolt-rope needle, or a marline spike, a number of short pieces of rope yarn, or spun yarn.

**THUMMERSTONE.** This stone was first described by Mr. Schreber, who found it near Balme D'auris in Dauphine, and gave it the name of shorl viole. It was afterwards found near Thum in Saxony, in consequence of which Werner called it Thummerstone. It is sometimes amorphous, but more commonly crystallized.

**THUNDER**, the noise occasioned by the explosion of a flash of lightning passing through the air; or it is that noise which is excited by a sudden explosion of electrical clouds, which are therefore called thunder-clouds. The rattling in the noise of thunder, which makes it seem as if it passed through arches, is probably owing to the sound being excited among clouds hanging over one another, and the agitated air passing irregularly between them. The explosion, if high in the air, and remote from us, will do no mischief; but when near, it may and has, in a thousand instances, destroyed trees, animals, &c. This proximity, or small distance, may be estimated nearly by the interval of time between seeing the flash of lightning, and hearing the report of the thunder, estimating the distance after the rate of 1·142 feet per second of time, or $3\frac{2}{3}$ seconds to the mile.

**THWARTS**, the seats or benches of a boat whereon the rowers sit to manage the oars.

**THYMUS**, Thyme, a well-known aromatic garden plant, highly useful for domestic and medicinal purposes.

**TIARA**, an ornament with which the ancient Persians covered their heads.

**TICK**, a troublesome insect which infests cows, goats, sheep, dogs, horses, and occasionally man.

**TIDE**, a regular periodical current of the water, setting alternately in a flux and reflux, and is produced by the influence of the moon. Locke, in describing the theory of the tides, observes, "That motion of the water, called tides, is a rising and falling of the sea; the cause of this is the attraction of the moon, whereby the part of the water in the great ocean which is nearest the moon, being most strongly attracted, is raised higher than the rest; and these two opposite elevations of the surface of the water in the great ocean following the motion of the moon from east to west, and striking against the large coasts of the continents; from thence rebound back again, and so make floods and ebbs in narrows, seas, and rivers."

The great Sir Isaac Newton undertook to explain the doctrine of the tides upon the two great principles of gravity and attraction. However irregular they might be in certain instances, and with a view to certain objects, it was evident, that from the stated intervals of the time which they preserved, some common and general cause must exist to produce such a regular effect. Continued observation had ascertained one striking and remarkable fact on all the coasts of the British dominions in Europe, and along the coasts of Holland, France, Spain, and Portugal, that the hour of high water, considered generally, was regularly and uniformly at a certain interval or portion of time after the moon had passed the meridian of such place. The acute and sagacious mind of this philosopher was, from mature deliberation, and attention to this fact, soon convinced that the moon had an influence upon the great body of the waters of the ocean, and that the only remaining subject of consideration was, to discover how far this principle would agree with the different quantity of waters which were accumulated at those intervals on different days. On this subject he might thus judiciously argue with himself: If it be true that the moon has an influence on the waters of the ocean, so as to occasion their accumulation in a regular and periodical way, which cannot be done by any thing but the force of attraction, it is equally probable, that the other heavenly bodies should have some influence to the same purpose. But the sun alone, from his magnitude, is capable of doing this in any considerable or sensible degree, and though from his distance that effect and influence be very much lessened, yet, upon calculation, it would be found to bear a proportion extremely well suited to obviate the remaining difficulty. First, it should be observed, that the earth has a daily revolution on its axis every twenty-four hours from west to east, which occasions the sun and other heavenly bodies apparently to move from east to west. But the moon, from her actual motion in the heavens towards the east, of a little more than twelve degrees daily, or near forty-nine minutes of time at a medium, occasions her coming upon the meridian of any place later by forty minutes daily than on each next preceding day, so as to take up about twenty-nine days and a half on an average from one new moon to another. Now, if both the sun and moon are supposed to have an attractive power and influence on the waters in the ocean, it must follow, that when they happen to be on the meridian at the same time, or nearly so, this attraction of each, whatever may be the proportion between them, must be the same way. It will from hence follow, that the effect of the sun's influence must in this case be added to that of the moon, and consequently an increased accumulation of waters must be produced. This is in reality the case at every new moon, when these two attractive bodies affect the waters of the ocean the same way, and cause higher tides, which are usually known by the name of spring tides. This will also account for the same sort of tides at the full moon, when the moon is at the greatest distance from the sun, or due north when the other is south. For we shall presently see, that the accumulated tides will always take place on the opposite parts of the world, to preserve a proper equilibrium, unless where other causes operate to the contrary; and therefore, though the two attracting bodies be in opposite parts of the heavens, they will operate jointly, as at the new moon, to produce high tides. On the contrary, when they are at the distance of a quarter of the heavens from each other, or ninety degrees, their influence will be manifestly different from each other, and the attraction will operate on different parts of the ocean, so as to counteract one another. Hence it would follow, that if the attractive power of these two bodies were equal, they would then destroy each other, as their united power at the full and new moons would be double to either of them singly. This, however, is not the case, though it is certain that at the time of the quarters of the moon, when the moon still evidently retains a prevailing influence, it is much counteracted by the attractive power of the sun, so that the tides are comparatively much less, and are known by the name of neap tides. It is likewise to be observed, that the tides, from the prevailing influence of the moon, would always naturally follow her from east to west, if the obstructions of land lying in the way did not prevent it. But water, as a ponderous body, though fluid, will more speedily seek to preserve its own level, and is less liable to interruption from slight causes, than the air or atmosphere, so that whatever impediments it meets with, it turns round the shortest points of land for this purpose, and seeks every creek and river in its course, that no part of the sea or ocean may be deprived of its share of the tides, and to recover its level.

It will be evident on the principles of attraction and gravitation, that as the hemisphere nearest to the moon will be immediately under the effect of her attraction, and consequently, the waters of that half be prevented from gravitating towards the other, the opposite hemisphere will have less than its share of attraction, and consequently the gravitation will be diminished, from whence the waters of the extreme part will be higher than in any other part of the hemisphere, so that the tides will then be highest at the same time. Hence, at the distance of ninety degrees, where this influence can be little if at all perceived, the waters will be at liberty to descend towards the centre by the natural power of gravitation, and will therefore in those places be lowest. It has also been concluded, that where the moon's meridian altitude is great, the tides will be increased when she is above the horizon; and, on the contrary, that when her meridian depression is great, the night tides will be most considerable. This holds true in a less degree of the sun, and especially at the new moon, if she has north declination in summer, and south declination in winter. Also, if the moon is in such a part of her orbit as to be at the nearest distance from the earth, it will considerably add to the influence of her attraction; and it has been known to cause uncommonly high tides when this happens at the time of new or full moon. Generally understood, it has been noted, that the morning tides are the highest in winter, and the evening tides in summer. It has been observed, that the intervention of land causes a great alteration in the tides. This will shew why there are little or no tides in small inland seas, such as the Baltic and Mediterranean, where the attractive influence of the sun and moon must be nearly equal at both the extremities, and cannot therefore sensibly affect the waters. It is also certain, that the tides are very inconsiderable in high latitudes, because the sun and moon more immediately act towards the equator, and raise the water towards the middle of the torrid zone, which must consequently render the waters of the frigid zone comparatively low, by depriving the neighbourhood of the poles, of those waters that are thus attracted towards the middle of the globe.

We shall now notice the proportion of the attractive influence of the sun and moon, as to their effect on the waters, and then point out the progress of the tides along the coasts of Europe. It has been observed, that on a supposition that the joint force being ascertained in any particular port at twelve feet, at a medium height of spring tides, without any extraordinary addition or diminution of the attracted power, that of neap tides has been found to be somewhat less than eight feet. Hence, as the united force of the attraction of the sun and moon is twelve, and by a contrary effect is reduced to eight, that of the moon singly must be equal to ten, and that of the sun to nearly two, and this proportion, generally considered, will almost constantly hold good on all the coasts of the united kingdom. There is another principle of the solar system, on which also this matter may be demonstrated. For as all the bodies attract each other mutually, but in an inverse ratio, in proportion to the squares of their distances, conjointly with their magnitude, this influence of the sun will also be found nearly to coincide with this general and fundamental law of the universe.

It has been seen that the natural course of the tides and currents of the ocean must be from east to west. This would be the case nearly, and almost uniformly, if the interposition of extensive continents did not prevent it. From the northern extremity of Europe, at the north end of Wiegat's Straits, in lat. 78 degrees N. to the Cape of Good Hope, in lat. 34 deg. S. there is no known passage for the waters of the ocean, in that or any other direction, but along the coasts. The medium situation between these two extremes, is about 22 deg. N. which is near Cape Blanco on the west coast of Africa. But the least shadow of a chart or map must be sufficient to satisfy any person of the impossibility of the flood tides setting there to the westward, because the continent for 56 deg. to the N. and S. entirely bounds that sea on the east. If therefore the tides are not totally interrupted by this vast extent of continent, they must come in either from the north or along the coast of Europe in a direction southward, or from the south in a direction northward along the west coast of Africa from the Cape of Good Hope. Such being the state of the case from argument, so it is in fact, as proved by common observation and experience; for it is well known that the flood tide sets to the southward along the west coast of Norway, from the North Cape to the Naze, for an extent of 13 deg. to the entrance of the Baltic Sea, and that from thence it proceeds southward to the coast of Great Britain, supplying every port successively in its passage. The large island of Great Britain breaks the regular course of the waters, and causes a division on their approaching that coast; and as the current comes from the northward, the coast of Scotland, as must naturally be expected, will first have the tide of flood, before the parts which are farther situate to the south. As the island of Great Britain divides this current into two channels, its operation on the eastern coast may first be regarded. The natural tendency to the west is here interrupted by the land, so that it must run to the southward as the only possible direction it can take. Hence it is found that at Aberdeen, on the coast of Scotland, the tide will be at its height on full and change days at a quarter before one o'clock, but that it will not be high water at Tinmouth Bar, on the coast of Northumberland, till three o'clock on the same days. All the intermediate ports, from thence to the Spurn, will have it progressively latter, where it does not reach till about five o'clock; and before it gets as far as Yarmouth Road, it will be at least eight o'clock. From thence it runs on still to the southward to Harwich, which it reaches at half past ten, and to the Nore, to which it does not come till twelve.

The other channel, which passes the north point of Scotland, and runs along the west coast of Great Britain at the same time, is subdivided into two channels by the interposition of Ireland. But the tide of flood between the south-west of Scotland, and the north-east point of Ireland, from the narrowness of the sea, is much the least in quantity, and therefore makes a much slower progress after its access to St. George's Channel, so as not to get farther than about the parallel of latitude of the Isle of Man. It would, nevertheless, advance forward to the south, if, as it will appear, a superior and controlling tide did not here put a termination to it. During this time, the main part of the western branch of the tide has been rapidly hurrying along the west coast of Ireland, in an open sea, where it has nothing to interrupt it till it arrives at the south-west part of that kingdom, so as to be at Cape Clear soon after four o'clock, which is an hour before it could reach the Spurn by the east channel. Hence, therefore, it must naturally turn round the south coast of Ireland, and it will have reached Waterford by five o'clock, near the south-east extremity of Ireland. Here, then, the tide will not only push on to the eastward for the English channel, but as the tide from the southward has been quickly setting to the north-east across the bay of Biscay, it will unite with this current to supply the deficiency of water in the English channel and the Irish Sea, or St. George's channel, and consequently proceed along the south of England and the north coast of France. For these two tides, by their joint influence, cause the tides along the south coast of Cornwall to be at the highest at new and full moon, some time in the interval from five to six o'clock, and along the east coast of Ireland a branch of them will slowly pass along to fill up the bays and channels there and on the coast of Wales, till it meets the branch which came in from the north through the narrow sea between Ireland and Scotland. At the time of this meeting it will be high water in the sea, which is between ten and eleven o'clock. At the same time, the main branch of these united tides is pressing along up the English channel till it meets the tide, or first principal branch of the current, which had washed the north-east and east coasts of Scotland and England, somewhere between Beachy Head and Dungeness; or, as some persons rather conclude, not far from the Godwin. If we take farther notice of the effects of these several tides on large rivers and bays, it will be farther evident that they will occupy some time, while the main body of those tides is pursuing its general progress along the adjacent coasts of the seas it passes through. Thus it is found that the tide will be an hour in passing up from the point of the Spurn to the town of Hull, or Kingston upon Hull, where it is not high water on full and change days till six o'clock. And the union of the two tides in the neighbourhood of the Godwin sands occasions a vast influx of water into the river Thames, and contributes to produce the powerful tides which run up that river to London.

The same reason will also afford a solution to the difficulty of the slow advance of the tides in St. George's or the Irish sea; for if the narrowness of the strait between Scotland and Ireland on the north be attended to, and the bending of the coast round the Mull of Galloway to the eastward as far as Solway Frith, that small influx of water must be a long time in filling the several bays and inlets of that coast; so that, although the tides do not enter the southern part of this sea till some hours after, the more spacious inlet of that extremity will admit a proportionably greater quantity of water. Hence, after this branch of the tide has filled up the Bristol channel or Severn sea on the east, and Cardigan Bay to the north-east, which must employ a space or interval of some hours, it passes up to the north of Dublin, and meets the former tide in the parallel of the Isle of Man; from whence, as soon as it is high water, the ebb tides return back again by their respective channels, till they are lost in the main ocean of the Atlantic.

The time of high water at any particular port must therefore be determined from observation and experience, as, from these interruptions, it is clear that no general principles can be laid down, on which it can be resolved from the longitude or comparative situation of any place on the face of the globe. But the general rule already laid down for the intervals of high water will always prevail; and when once the time of high water has been ascertained on the days of new and full moon at any port, the succession of those tides will be daily about 49 minutes later than on each preceding day respectively. It must always however be remembered, that there is another tide in the intermediate time, or about 12 hours and 24 minutes after the next preceding tide, and so on progressively. It may sometimes happen that in mentioning the time of high water at any particular port, cape, headland, or any other remarkable place of the sea or ocean, it may be expressed generally, or without any reference to its being understood of the time on the very days of new or full moon; which perhaps, to seamen, could scarcely admit of any doubt, but to others, less conversant with their general language and modes of speech, may be less intelligible. We have sometimes also expressed ourselves generally of the time of spring tides; by which, likewise, is constantly meant the precise day of new or full moon, though the tides for two or three days are frequently represented by that term; and indeed, it has been observed from experience, that the highest tides are not usually till the third or fourth tide, according as the day or night tides are highest from other causes, after the actual new or full moon, whereas, in speaking of the time of spring tides generally, it is always to be understood of the very day. The time of high water being accordingly ascertained by observation at each particular port, the next conclusion resulting from thence has been to represent the point of the compass, being first corrected for variation on the day on which the moon is at that time. Having, therefore, determined this, according to the proportion of 11 degrees and a quarter for each point of the compass, pilots and seamen in general have attended to the rule in laying down the time of high water on the intermediate days between the spring-tides. This is, in other words, to allow three quarters of an hour for each point of the compass; and on this foundation it is that in places where it is high water at noon on full and change days, as at Southampton or Ostend, the tide is said to flow north and south at 12 o'clock. Thus also if the moon on those days bears 1, 2, 3, or more points to the eastward or westward of the meridian of any place at the time of high water, the tide is said to flow on such a point. For example, if the moon bears S.E. at the time of high water at Poole in Dorsetshire, the tide will here be said to flow at S. E. and N. W. and if E. or W. at Plymouth in Devonshire, it will be said to flow east and west. But it is a very improper way to depend on the point of the compass alone for the time when the moon is to be at high water, unless it has been converted into time, and ascertained by the interval after passing the meridian. Thus, for instance, if it were understood that the moon is always to be east or west at the precise time of high water at Plymouth, conclusions the most gross, erroneous, and dangerous, would be the result; because when the moon has a high north declination, it may happen that she may not be due east till near eight o'clock in the morning at Plymouth, which will almost be two hours after high water, and it would on the same day be due west soon after four o'clock in the afternoon, which will be nearly two hours before high water. It is needless to enlarge on the danger of abiding by this mode of calculation, without converting it into time at the rate of three-quarters of an hour for every point of the compass. But the general and only safe rule is, to say, that it will be high water at six hours after the moon has passed the meridian. It is high water in some places on the shore, or by the ground, while the tide continues to flow in the fair way or offing, as it is called, by which term is understood, that part of the sea in the neighbourhood, or at no great distance from any coast, where the tide-way is not particularly interrupted by the adjacent shore or high land. For this state of the tides it is customary to say, that the water flows tide and half tide, or tide and quarter tide, and the like, thereby considering the usual run of the tide at six hours, and the half tide at three hours, &c. When, therefore, the current or stream of the fair way in the offing of any coast is said to run tide and quarter tide, for instance, it means that the stream runs an hour and a half longer in the offing than it does by the shore, and consequently that it does not begin to run so soon any particular way at a distance from the coast as it does close by the land, by that interval of time.

There is yet one circumstance more to be noted respecting the mode of calculating the time of high water on the intermediate days between the spring-tide days. We have already pointed out the extremely dangerous notion of reckoning the tides by the points of the compass for any particular ports, and especially those which are nearest to the east and west. There is likewise another irregularity of considerable importance, which is, applying too generally and successively the rule of adding 49 minutes daily to the time of high water on each preceding day. Experience has proved this common method of calculation to be frequently erroneous.

With regard to the relative force of the tide on a ship floating herein, see the article Current.

Tide-gate, a place in which a tide runs with great velocity.

*To* Tide, to work in or out of a river or harbour, or channel, by favour of the tide, and anchoring whenever it becomes adverse.

Tides *Man*, an officer appointed by the custom-house to reside on board of merchant ships while they have any customable goods on board.

Tide *Mills*, as their name imports, are such as employ for their first mover the flowing and ebbing tide, either in the sea or a river, and particularly the Thames, the Humber, and the Severn, in which the tide rises to a great height, furnishing a very powerful mover to drive any kind of machinery, and would allow of tide mills being very advantageously constructed upon their banks. The erection of such mills is not to be recommended universally, as they are attended with a considerable original expense, besides that some of their parts will require frequent repairs; but in some places where coals are very dear they may, on the whole, be found less expensive than steam engines to perform the same work, and may on that account be preferred even to them.

Tide *Way*, the channel in which the tide sets.

Tide *Waiters*, or Tidesmen, are inferior officers belonging to the custom-house, whose employment it is to watch or attend upon ships until the customs are paid.

TIER, a name given to the range of cannon mounted on one side of a ship's deck.

Tier *of the Cable*, is a range of the fakes or windings of the cable, which are made within one another in a horizontal position.

*Cable* Tier, the space in the midst of a cable when it is coiled, also the place in which it is coiled.

Tier, also implies a range of casks in the hold; hence we say, the *Ground* Tier, or that which is next above the keelson, the second tier and upper tier.

TIERCE, or Terce, a measure of liquid things, as wine, oil, &c. containing the third part of a pipe, or forty-two gallons.

TIGER. *See* Felis.

Tiger *Shell*, a beautiful species of voluta, of a dusky red colour, spotted all over with large irregular blotches of white.

TIGHT, the quality whereby a vessel resists the penetration of any fluid, whether compressing its surface, or contained within it. Hence a ship is said to be tight when the planks are so solid as to prevent the entrance of the water, and a cask is called tight when none of the liquid contained therein can issue through or between the staves; in both senses it is opposed to leaky, which article see.

TIGILLUM, a word used by chemists to express the tile with which they cover the mouth of their crucibles; and, by others, for the crucible itself.

TILE, in building, a sort of thin brick, used on the roofs of houses; or more properly a kind of clayey earth, kneaded and moulded of a just thickness, dried, and burnt in a kiln like a brick, and used in the covering and paving of different kind of military and other buildings.

TILIA, in Botany, the *Lime Tree*, of which there are a great variety of species.

TILLAGE, the cultivating of land, or the means of bringing it into a state of preparation for depositing the seeds, and the growth of different crops.

TILLER, the bar or lever employed to turn the rudder in steering. See the article Helm.

Tiller *Rope*, the rope which forms a communication between the fore end of the tiller and the wheel, and is usually made of untarred rope.

TILT, a small canopy or awning of canvass or other cloth, extended over the stern sheets of a boat, and supported by iron work, or broad laths of flexible wood, incurvated. The tilt is principally used to keep off rain, as an awning is intended to defend from the sun's heat.

Tilt, the covering of a cart, waggon, or other carriage, supported by hoops, and easily removeable when occasions require.

Tilt *Boat*, is a boat covered with tarpawling or sail-cloth, to shelter the passengers, and such goods as might otherwise be exposed to the action of sun or rain.

Tilt *Hammer*, a large and heavy hammer, put in motion by a water wheel or steam-engine. Cogs being brought to bear on the tail of the hammer, its depression causes the head to be elevated, which, when liberated, falls with considerable force by its own specific gravity. Tilt mills work on the same principle.

TILTING *of Steel*, is the process by which blistered steel is rendered ductile. This is done by placing it under the tilt hammer.

TIMBER, includes all kinds of felled and seasoned woods. Of all the different kinds known in Europe, oak is the best for building, and even when it lies exposed to air and water there is none equal to it. Fir timber is the next in degree of goodness for building, especially in this country, where they build upon leases. It differs from oak in this, that it requires not much seasoning, and therefore no great stock is required beforehand. Fir is used for flooring, wainscoting, and the ornamental parts of building within doors. Elm is the next in use, especially in England and France; it is very tough and pliable, and therefore easily worked; it does not readily split, and it bears driving of bolts and nails better than any other wood; for which reason it is chiefly used by wheel-wrights and coachmakers, for shafts, naves, &c. Beech is also used for many purposes; it is very tough and white when young, and of great strength, but liable to warp very much when exposed to the weather; and to be worm-eaten when used within doors; its greatest use is for planks, bedsteads, chairs, and other household goods. Ash is likewise a very useful wood, but very scarce in most parts of Europe; it serves in buildings, or for any other use, when screened from the weather; handspikes and oars are chiefly made of it. Wild chesnut timber is by some esteemed as good as oak, and seems to have been much used in old buildings; but whether these trees are more scarce at present than formerly, or have been found not to answer so well as was imagined, it is certain this timber is now but little used. Walnut-tree is excellent for the joiner's use, it being of a more curious brown colour than beech, and not so subject to the worms. The poplar, abel, and aspen trees, which are very little different from each other, are much used instead of fir, and look well.—The goodness of timber not only depends upon the soil and situation in which it stands, but likewise on the season wherein it is felled. In this, people disagree very much; some are for having it felled as soon as the fruit is ripe, others in the spring, and many in the autumn. But as the sap and moisture of timber is certainly the cause that it perishes much sooner than it otherwise would do, it seems evident that timber should be felled when there is the least sap in it, *viz.* from the time that the leaves begin to fall till the trees begin to bud. This work usually commences about the end of April in England, because the bark then rises most freely; for where a quantity of timber is to be felled, the statute requires it to be done then for the advantage of tanning. After timber has been felled and sawed, it must be seasoned; for which purpose some advise it to be laid up in a very dry airy place, yet out of the wind and sun, or at least free from the extremities of either: and that it may not decay, but dry evenly, they recommend it to be daubed over with cow-dung. It must not stand upright, but lie all along, one piece over another, only kept apart by short blocks interposed to prevent a certain mouldiness, which they are otherwise apt to contract in sweating on one another; from which arises frequently a kind of fungus, especially if there be any sappy parts remaining. Others advise the planks of timber to be laid for a few days in some pool or running stream, in order to extract the sap, and afterwards to dry them in the sun or air. By this means, it is said, they will be prevented from either chopping, casting, or cleaving, but against skrinking there is no remedy. Some again are for burying them in the earth, others in a heat, and some for scorching and seasoning them in fire, especially piles, posts, &c. which are to stand in water or earth. The Venetians first found out the method of seasoning or charring by fire; which is done after this manner; they put the piece to be seasoned into a strong and violent flame, in this they continually turn it round by means of an engine, and take it out when it is every where covered with a black coaly crust; the internal part of the wood is thereby so hardened, that neither earth nor water can damage it for a long time afterwards.

TIMBER *Trees*, in Law, are properly oak, ash, and elm. In some particular countries, by local custom, other trees being commonly there made use of for building, are considered as timber. Of these, being part of the freehold, larceny cannot be committed; but if they be severed at one time, and carried away at another, then the stealing of them is larceny. And by several late statutes, the stealing of them in the first instance is made felony, or incurs a pecuniary forfeiture. For the better preservation of roots, shrubs, and plants, it is enacted by 6 George III. c. 48, that every person convicted of damaging, destroying, or carrying away any timber tree or trees, or trees likely to become timber, without consent of the owner, &c. shall forfeit for the first offence not exceeding 20l. with the charges attending; and on non-payment shall be committed for not more than twelve, nor less than six months; for the second offence a sum not exceeding 30l. and on non-payment shall be committed for not more than eighteen, and not less than twelve months; and for the third offence, is to be transported for seven years. All oak, beech, chesnut, walnut, ash, elm, cedar, fir, asp, lime, sycamore, and birch trees, shall be deemed and taken to be timber trees, within the true meaning and provision of this act. Persons convicted of plucking up, spoiling, or taking away any root, shrub, or plant, out of private cultivated ground, shall forfeit, for the first offence, any sum not exceeding 40s. with the charges; for the second offence, a sum not exceeding 5l. with the charges; and for the third offence are to be transported for seven years. A power is given to justices of the peace to put this act in execution.

TIMBERS, the ribs of a ship, or the incurvated pieces of wood branching outward from the keel in a vertical direction, so as to give strength, figure, and solidity to the whole fabric. One timber is composed of several pieces united into one frame, which is accordingly called a frame of timbers, by the artificers.

*Square* TIMBERS, are those whose planes are perpendicular to the keel.

*Cant* TIMBERS, are those which are placed obliquely on the keel, as at the extremities of a ship.

*Knuckle* TIMBERS, are the foremost cant timbers on a ship's bow; the hindmost on the quarter are termed fashion pieces.

TIMBER *and Room*, or *Room and Space*, is the distance between the moulding edges of two adjoining timbers, which always contain the breadth of two timbers, and sometimes two or three inches between them.

*Filling* TIMBERS, are those which are put up between the frames. It must be observed, that one mould serves for two timbers, the fore side of the one being supposed to unite with the after side of the other, and so make only one line, which is actually the case in all the frames, which in some ships are every third, and in others every fourth timber. The frames are first put up and fastened to the ribands, and afterwards the filling timbers are put up.

TIMBER *Heads*. See the article KEVEL HEADS.

TIME, a measure or portion of infinite duration. It is generally ascertained by the motions of the heavenly bodies.

TIME, in Music, is an affection of sound, by which we denominate it long or short with regard to its continuance.

TIME *Keepers*, in a general sense, denotes instruments adapted for measuring time. *See* CHRONOMETER.

TIMEKEEPER, or TIMEPIECE, an instrument adapted for measuring time. See the article LONGITUDE.

The following remarks on time-keepers were communicated by Joseph Whidbey Esq. master attendant at Sheerness yard, master of the Discovery sloop, and afterwards of the Sanspareil, and who surveyed 3000 leagues of the N. W. shore of America.—"When a time-keeper is received on board a ship, the greatest care should be taken to have it immediately secured in some convenient place in the cabin, where it may be the least liable to be moved during the voyage: it should never be touched but at the time of winding up, which ought to be at noon, and then with the greatest care, particularly avoiding circular motion. The makers of these instruments will affirm, that it is unnecessary to be thus particular in the care of them, and will tell you they may be carried about in the pocket, and moved from place to place, without being the least affected by it. I can only say, that I have been in the habit of using time-keepers for some years, and, notwithstanding the sanguine expectations of the makers as to their perfection, in my experience I have found the above precautions necessary. I have frequently known time-keepers alter their rates, in carrying them from the ship to the observatory, and again from the observatory to the ship, when I have every reason to suppose that, had they remained quiet on board, there would have been no alteration in their rates. I do not mean to say this will universally be the case, I have had many instances to the contrary; I should hope that as so many skilful men are at this time employed to bring this piece of mechanism to perfection, they will ultimately succeed in obviating every objection that possibly can be started against them. Not that I allow the above to be an objection against time-keepers, because a rate may be given them without moving them from the place where they were first fixed, as I shall explain hereafter. I would only express, that too much care cannot be taken of an instrument which will answer so grand a purpose as that of ascertaining a ship's exact position, almost at any time, in any part of the ocean. When a time-keeper is received on board, its rate, or the number of seconds it gains or loses in twenty-four hours, with the time which it was fast or slow of mean time at Greenwich, on some certain day, is given from the observatory with it. It will not be amiss to note this rate carefully every day at noon, in a book kept for that purpose, so that it may be known at any time, without any farther calculation, what the time-keeper is fast or slow of mean time at Greenwich. If the time-piece is slow of mean time at Greenwich, and losing, add its daily rate to its error every day. What is here meant by error is the quantity the time-piece is fast or slow of the meridian reckoned from, and not the error that is occasioned by any irregularity in the going of the machine, and which, to the extent of it, would occasion a wrong determination of the longitude. This sum must be added to the time it shews, to give Greenwich mean time; if it is slow, and gaining, subtract its daily rate and add the remainder to the time shewn by it for the Greenwich mean time. If the time-keeper is fast, and gaining, add the daily rate, and subtract the sum; or if it is fast, and losing, subtract the daily rate, and subtract the remainder from the time shewn by the time-keeper, to obtain the Greenwich mean time. It is evident that when the time-piece is fast, and losing, its error will decrease till it becomes slow; and then the error will increase; also, if it is slow, and gaining, its error will decrease till it becomes fast, and then will increase. When by this correction of the time-piece the mean time at Greenwich is known, all that is wanted is the mean time at the ship. The difference between them is the longitude of time, which is west, when the Greenwich mean time is the greater of the two, and east when it is the less. To prevent the moving of a time-piece, the observer should be provided with a pocket watch, having a seconds hand. This should be compared with the time-piece, noting the difference both immediately before and after taking altitudes. If the difference be not the same before and after, correct it in the proportion of the elapsed times, before you apply it to the time shewn by the pocket watch, to give the time shewn by the time-piece. The rate of a time-piece should often be tried, and if it is found to have altered, a new rate should be given. The alteration may be discovered, and a new rate given as follows: In any harbour, which has been regularly surveyed, and the latitudes and longitudes well ascertained, the bearing of any two points will determine the ship's position on the chart: thus the ship's latitude is known. Let altitudes be taken, and from them find the longitude by the time-piece: if this differs materially from the ship's longitude, it is fair to conclude that the time-keeper has altered its rate.—If the ship stays a week or ten days in the same place, a new rate may be given it, by taking altitudes as often as is convenient until the ship sails; noting the difference of the longitudes given by the time-piece the first and last day; then turning this difference into time, and dividing that time by the number of days from the time of taking the first altitudes, to the time of taking the last; the quotient will be an increase, or decrease, to be applied to the old rate. If the place be to the westward of Greenwich, the Greenwich time is greater than the time at the place; consequently, if the time-piece gives a greater longitude on the last day than it did at the first, it is gaining; if a less, it is losing; if the place is to the eastward of Greenwich, the contrary is true. By this mode, the rate of a time-piece may be found on board; and, indeed, I would always recommend this method, particularly to those who have the charge of navigating a ship. Undoubtedly the best and surest mode of finding the rate of time-keepers, is by a well-regulated clock on shore, or by equal altitudes taken by an astronomical quadrant. As neither of these can be used on board a ship, a substitute is required. I know of none better than a quicksilver horizon; which with care can never lead to any error: it is therefore far preferable to the sea horizon, which is liable to a considerable error. When I have been in an observatory, finding the rate of time-pieces by a well-adjusted astronomical quadrant, I have frequently, for experiment sake, tried the quicksilver horizon, and brought out the rate the same as by equal altitude. I have found the quicksilver horizon capable of fixing the latitude of a place nearly as accurately as an astronomical quadrant. It is made small enough to be carried in the pocket. With a sextant it may be called a portable observatory; and a person may with these two instruments regulate his time-pieces, wherever he may chance to stop. The quicksilver horizon shews twice the true altitudes, *i.e.* Suppose the sun's altitude is taken by a quicksilver horizon, and measures on the sextant 90°, half that sum, or 45°, will be the altitude of the sun's lower limb; which is to be treated as a common altitude, except that there is no correction for the dip of the horizon.

"Let us now suppose a time-piece to be fixed in a ship; the observer to be provided with a quicksilver horizon, a sextant, and a pocket watch with a seconds hand, which goes tolerably well, and that he wishes to find the rate of his time-piece: let him set his pocket watch to the same second with the time-piece, if it is a stop watch; otherwise let him compare it, noting the difference; then let him go on shore with his quicksilver horizon, and take altitudes; let him immediately return on board, and compare again, and if the pocket watch has altered its difference from the time-piece, let him make the proper proportion for the error, according to the elapsed times, as above directed, to find the time which the time-piece shewed when the altitudes were taken; with this, the altitudes may be used as if the time-piece had been taken on shore; and in this way the rate may be found. I should remark, that when the observation is made, the sun's altitude should not be found less than 8°, as late as $9^h$, or half past $9^h$, if it is in the morning, or about the same distance from noon, namely, half past two in the afternoon. This method is much superior to that where the sea horizon is used: indeed, it is very little inferior to that by the astronomical quadrant. If a person is near an observatory, a rate may be given to a time-piece without moving it, merely by setting the pocket watch with the time-piece, and comparing it with the clock at the observatory several times a week. If a time-piece is brought on board without a rate, and it is not known how much it is fast or slow of Greenwich mean time, or if it has been let down while on board, (by which latter case I shall illustrate this point,) if the ship remains in the same place ten or fourteen days, a rate may be given it in the following manner.—Wind it up, and set it going as near Greenwich time as possible, in order that the difference may be little between Greenwich time and the time-piece. Suppose on September 26, 1797, I let my time-piece down, and set it going on the 27th, I take the altitudes at $9^h\ 2'\ 16''$ by the time-piece; and I find my apparent time to be $2^h\ 53'\ 18''$ from noon; this subtracted from $12^h$ (the observation being in the morning) leaves $9^h\ 6'\ 42''$. The equation taken from the Nautical Almanack for that time ($9'\ 13''$) being subtractive, leaves $8^h\ 57'\ 29''$; this then is not the solar but the mean time. This time applied to $9^h\ 2'\ 16''$, makes a difference of $4'\ 47''$.—If by this method you find the same difference every day, the time-piece is going at mean time; if the difference is greater, the time-piece is gaining the increase of difference every day; if the difference is less, the time-piece is losing the decrease of difference every day; because in this case, the time-piece shews a greater time than the mean time worked. If the time-piece had shewn a less time than the mean time worked, the contrary would have been the case. The various uses of time-pieces can only be known to those who are in the habit of working and studying them. I believe I have sufficiently explained in what manner they are to be taken care of, and how their rates are to be found and managed; it only remains for me to explain their uses as far as my experience enables me. The first and most essential is with the latitude, to ascertain the exact place of the ship, any day and several times a day, if necessary, in any part of the ocean when the sun is visible. Secondly, it has before been recommended to take altitudes about $9^h$ or half past $9^h$ in the morning, for finding the longitude. Having these, you will always be sure of the first of double altitudes, should there be any appearance of losing the meridional altitude by clouds or mists arising near noon. Thus, it may frequently happen that the navigator may have both longitude and latitude, when, without the use of a time-keeper, he might be disappointed of both. Thirdly, it very often happens, particularly in high latitudes, that in a cloudy day the sun will shew itself on or about passing the meridian. Having a time-piece, you can tell, within a minute, when the sun is on the meridian: if an altitude can be caught about that time, even so far as ten minutes before or after the sun passes the meridian, that altitude will give the latitude nearly; for in such latitude, particularly when the sun's declination and the latitude are of different names, the sun's altitude alters very little in ten minutes on either side of noon. Fourthly, time-keepers are of great use in carrying on lunar distances from one day to another, so that a number of observations may be brought to one point. Altitudes being taken at the proper time by the time-piece, the apparent time thus obtained will answer for any lunar distances taken in the course of the succeeding twenty-four hours. The method of carrying on or deducing the time of taking the distances, to the time of taking altitudes for the longitude, may be illustrated as follows:

Suppose that altitudes are taken for the longitude in the morning, and that several sets of lunar distances are observed in the afternoon. Take the elapsed time from observing the altitudes, to the time of each set of distances, and when the Greenwich time of the distances is brought out, subtract this elapsed time from the Greenwich time of each set: each remainder will be the Greenwich time when the altitudes were taken, and will produce an observed longitude for that time; not for the time when the distances were observed. On the contrary, if lunar distances are observed before altitudes are taken for the apparent time, the elapsed time of each set must be added to the Greenwich time, to bring each set up to the time when the altitudes were taken. Observations of lunar distances also may be carried on from one time to another, so as to enable the observer, after having gained a number of sets on each side of the moon, to bring them all to one point by the time-piece, and get a mean of all the observations, which will give the true longitude, if the observations are good.—This may be explained as follows:

Suppose, on January 20th, I observe six sets of lunar distances; on the 21st, four more; on the 23d, six sets more:—the 23d being the last day, when the distances are in the Nautical Almanack on that side the moon, I bring each set of distances to the time when the altitudes were taken on their respective days; I then take the difference of longitude shewn by the time-piece, on the 20th and 23d, at the time altitudes were taken on each day: I apply that difference to each set taken on the 20th. I do the same between the 21st and 23d; each set will then be brought to the time when altitudes are taken on the 23d; in all sixteen sets. The mean of these, if the observations are good, cannot be far from the truth, and the result may be brought to noon on that day by the log. But to be more certain of the observed longitude, I will carry on the sixteen sets as above directed, till I have obtained sixteen sets on the other side of the moon. These thirty-two sets being all carried on to the last day of observing their mean, I may consider as nearly the true longitude. By this method you may judge whether time-pieces have altered their rates or not; and may even give them a new rate, in the same way that you would have done in harbour, as I have before explained. Thus the lunar distances and time-piece may be made to go hand in hand with each other, to discover the ship's true longitude. A time-piece must be a very bad one indeed, if it will alter its rate to such a degree as to affect the observations while carrying on as I have described. A small difference of rate they are all liable to, but this will not materially affect the observations. There is a small correction to be made at the time of the year when the daily difference of the equation is great. If the elapsed time between the altitudes, for the apparent time and the lunar distances be many hours, it will make an error of some miles of longitude. This error, arising from the difference between mean and solar time, is not of much consequence at sea, or any where but in the observatory, where an astronomer is finding the exact longitude of his place by lunar distances, eclipses of Jupiter's satellites, occultations, transits, &c. When there are more time-pieces on board a ship than one, the same apparent time may be made to answer, to find the longitude by them all; by comparing the one, by which the altitudes were taken, with all the rest. Take the elapsed time between observing the altitudes and comparing; if the comparison is made after the observation, subtract this elapsed time from the time shewn by the second time-piece, when the comparison is made; the remainder is the time when the altitudes were taken, by the second time-piece: proceed then, as in common, to apply the error of its rate. The difference, then, between its time and the mean time at the ship, will be the longitude in time. For example: suppose altitudes were taken by No. 1, at $10^h\,50'\,51''$; No. 2 was compared with it at $13^h\,29'$ (by No. 1,) and shewed at that time $12^h\,44'\,36''$. The elapsed time between observing altitudes and comparing, is $2^h\,38'\,9''$; which taken from $12^h\,44'\,36''$ leaves $10^h\,6'\,27''$, which is the time by No. 2, when the altitudes were taken. Suppose No. 2 to be slow of mean time at Greenwich $38'\,40''$; that, added to $10^h\,6'\,27''$ gives $10^h\,45'\,7''$, which is the mean time at Greenwich according to No. 2. Suppose the mean time at the ship to be $9^h\,30'\,56''$, the difference between these mean times is $1^h\,14'\,11''$, which turned into longitude, is $18^\circ\,32'\,45''$; and as the mean time at Greenwich is greater than at the ship, the longitude is west. You may proceed in the same way with any other time-pieces on board.—In addition to the observations already made on time-pieces, I must advert to the very great importance of these instruments to officers charged with fleets or convoys, with respect to making short passages from one part of the world to another. A person who has a good time-piece will be enabled to steer straight courses. This will shorten the distance much, and by that very circumstance will frequently enable him to get a fleet into port, before a shift of wind which might otherwise keep him out a long time. It will likewise give an officer a good chance of escaping the vigilance of a superior enemy; as he need not, according to the common system of navigation, run into the latitude of his port, in which his enemy may be cruising a few degrees of longitude to windward for him. He may run his longitude down thirty or forty leagues north or south of the port, as it may happen, till he is nearly or exactly in the longitude of it; and then steer north or south to his destination, as the case requires. This mode of navigation might prevent the capture of many a valuable ship, and would certainly, by shortening the passages, in many instance cause a great saving, not only to government, but to the merchant.

**TIMONEER**, the helmsman or person who manages the helm to direct the ship's course.

**TIN.** This metal has a fine white colour like silver, a slight disagreeable taste, and emits a peculiar smell when rubbed. Its specificgravity is 7·291. It is very malleable. Tin leaf or foil is about $\frac{1}{1000}$ part of an inch thick, and it might be reduced to half this thickness. It is very flexible, and produces a remarkable crackling noise when bended, and when heated 442 deg. it melts. When exposed to the air, it very soon loses its lustre, and assumes a grayish white colour, but undergoes no farther change, neither is it sensibly altered by being kept under cold water; but when the stream of water is made to pass over red-hot tin, it is decomposed, the tin is oxidated, and hydrogen gas is evolved.

**Tin**-*Stone*, an oar of tin which occurs in masses, in rounded pieces, and crystallized. These crystals are very irregular. Colour dark-brown; sometimes yellowish gray; and sometimes nearly white. Somewhat transparent when crystallized. Specific gravity 6 9 to 6·97. Before the blow-pipe it decrepitates, and on charcoal is partly reduced. Tinges borax white.

**TINCTURE**, is commonly understood to be a coloured infusion of any substance in alcohol. It is a preparation much employed in pharmacy with many articles of the materia medica, particularly vegetable barks, aromatics of all kinds, and many of the resins and gum resins, which yield to alcohol, by infusion, that part of their substance in which most of the medicinal virtues reside.

**TINNING.** Tinning is the art of covering any metal with a thin coating of tin. Copper and iron are the metals most commonly tinned. What are commonly called tin-plates or sheets, so much used for utensils of various kinds, are in fact iron plates coated with tin.

The principal circumstance in the art of tinning is, to have the surfaces of the metal to be tinned perfectly clean and free from rust, and also that the tin may be perfectly metallic; and not covered with any ashes or calx of tin.

*Tinning of Iron.* When iron plates are to be tinned, they are first scoured, and then put into what is called a pickle, which is sulphuric acid diluted with water; this dissolves the rust or oxide that was left after scouring, and renders the surface perfectly clean. They are then again washed and scoured. They are now dipped into a vessel full of melted tin, the surface of which is covered with fat or oil, to defend it from the action of the air. By this means, the iron, coming into contact with the melted tin in a perfectly metallic state, it comes out completely coated. When a small quantity of iron only is to be tinned, it is heated, and the tin rubbed on with a piece of cloth or some tow, having first sprinkled the iron with some powdered resin, the use of which is to reduce the tin that may be oxidated. Any inflammable substance, as oil for instance, will have in some degree the same effect, which is owing to their attraction for oxygen.

*Tinning of Copper.*—Sheets of copper may be tinned in the same manner as iron. Copper boilers, saucepans, and other kitchen utensils, are tinned after they are made. They are first scoured, then made hot, and the tin rubbed on as before with resin. Nothing ought to be used for this purpose but pure grain tin; but lead is frequently mixed with the tin, both to adulterate its quality, and make it lie on more easily, but it is a very pernicious practice, and ought to be severely reprobated.

**TITANIUM**, a metal found in black sand, resembling gunpowder, in Cornwall. Its colour is orange red, and it has a good deal of lustre. As it has been only obtained in very small agglutinated grains, neither its hardness, specific gravity, nor malleability, has been ascertained. It is one of the most infusible of metals, requiring a greater heat to melt it than can be produced by any method at present known.

**TITHES**, are the tenth part of the increase yearly arising and accruing from the profits of lands, the stock upon lands, and the personal industry of the inhabitants. And hence they are usually divided into three kinds, prædial, mixed, and personal. Prædial tithes are such as arise merely and immediately from the ground, as grain of all sorts. hay, wood, fruits herbs; for a piece of land or ground being called in Latin prædium, whether it is arable, meadow, or pasture, the fruit or produce thereof is prædial, and consequently the tithe payable for such annual produce is called a prædial tithe. Mixed tithes are those which arise not immediately from the ground, but from things immediately nourished from the ground, as by means of cattle depastured thereupon, or otherwise nourished with the fruits; as colts, calves, lambs, chickens, milk, cheese, eggs. Personal tithes are such as arise from the labour and industry of man, employing himself in some personal work, artifice, or negotiation; being the tenth part of the clear gain, after charges deducted. Watts, c. 59. But this is seldom paid in England, except by especial custom.

**TITLE**, in Law, denotes any right which a person has to the possession of a thing; or an authentic instrument, whereby he can prove his right.

**TOAD.** *See* Rana.

**TOBACCO.** *See* Nicotiana.

**TODDY**, a juice drawn from various kinds of palms, by cutting off such branches as nature intended to bear fruit, and receiving from the wound the sap designed for the nourishment of the future crop. This juice undergoes fermentation, and, with other ingredients, is used in the distillation of arrack.

**TOGA**, a wide woollen gown or mantle, without sleeves, used among the Romans both by men and women.

**TOGETHER**, in a nautical sense, the order given to the men, in the exercises of heaving, rowing, hauling, hoisting, &c. to act all in concert, or at the same time.

**TOGGEL**, a small pin of wood, from four to six inches in length, and usually tapering from the middle towards the extremities, it is sometimes used instead of a hook in fixing a tackle, &c. In ships of war it is usual to fix toggels upon the running parts of the topsail sheets, the gears, &c. when preparing for action, in such manner that if the rope is shot away below, the toggel may stop the yard from coming down. This operation is called putting the sheets in the beckets. See the article Beckets.

**TOKAY Wine**, derives its name from a town or village in Hungary, where this delicious and costly liquor is produced.

**TOLERATION**, in Religion, is the liberty granted under the protection of law, to those who dissent from the rites and constitution of an ecclesiastical establishment, permitting them to worship God without molestation, agreeably to the dictates of their consciences. Few subjects have generated more controversies than those to which toleration has given birth.

**TOLUIFERA**, the balsam or tolu tree, a genus of plants of the class decandria and order monogynia. There is only one species, the balsamum. This balsam possesses the same general virtues with the balsam of Gilead, and that of Peru. It is, however, less heating and stimulating, and may therefore be employed with more safety. It has been chiefly used as a pectoral, and is said to be an efficacious corroborant in gleets and seminal weaknesses. It is directed by the pharmacopœias in the syrupus tolutaus, tinctura tolutana, and syrupus balsamicus.

**TOMBAC**, a metal composed of copper and arsenic.

**TON Weight**, 20 hundred.

**TONNAGE**, a custom or impost due for merchandise brought or carried in tons from or to other nations, after a certain rate in every ton.

**TONNAGE**, the same with Burthen, which article see.

**TONSURE**, in Ecclesiastical History, a particular manner of shaving or clipping the hair of ecclesiastics or monks.

**TONTINE**, a variable kind of life annuity, but generally so contrived as to be progressively increasing in amount. It is formed by nominating a certain number of lives within limited ages, who for each one hundred pounds or any other gross sum paid down, are to receive at first a specific annuity; but as any of the lives fail, their annuity is to be equally divided among those that remain, by which means those individuals who happen to survive a considerable number of years, obtain a large augmentation of their annual receipt; and the longest liver of the whole (if there is no restriction to the contrary) gets, for the remainder of his life, the total sum which was paid at first to all the nominees. Tontines of this kind, if properly conducted, are considered by some persons as affording an eligible opportunity of making some provision for children, as the nomination of good healthy lives gives a good chance for survivorship. It has several times been attempted to raise money on this species of annuity for the service of government, but it has never been found practicable to obtain any considerable sum in this way; on a smaller scale it has been adopted successfully, both in Great Britain and Ireland, for procuring the sums necessary for building bridges, large inns or hotels, and other expensive edifices.

**TOP**, a sort of platform surrounding the lower-mast head, from which it projects on all sides like a scaffold. The principal intention of the top is to extend the top-mast shrouds so as to form a greater angle with the mast, and thereby give additional support to the latter. It is sustained by certain timbers fixed upon the hounds and cheeks of the masts, and called the trestle-trees and cross-trees. The top is also very convenient to contain the materials necessary for extending the small sails, and for fixing and repairing the rigging and machinery with greater expedition. In ships of war, the tops are furnished with swivels, musketry, and other fire-arms, and are guarded with a fence of hammocks in time of action. Here the top is used as a kind of redoubt, and is accordingly fortified for attack or defence, being furnished with swivels, musketry, and other fire-arms, and guarded by a thick fence of corded hammocks. Finally, the top is employed as a place for looking out either in the day or night.

Top-*Armour*, a rail about three feet high, extending the width of the top on the afterside, supported by stanchions, and equipped with a netting, and sometimes with painted canvass.

Top-*Block*. *See the article* Block.

Top-*Chain.* *See the article* Chain.

Top-*Cloth*, a large piece of canvass, used to cover the hammocks, which are lashed in the top when prepared for action.

Top-*Lantern*, a large lantern placed in the after-part of a top in any ship where an admiral's flag or commodore's pendant is flying.

Top-*Mast*, the second division of a mast, or that part next above the lower-mast. See the article Mast.

Top-*Gallant-Mast*, the mast next above the top-mast, and is generally the uppermost mast.

Top-*Rope*, a rope employed to sway up a top-mast or top-gallant-mast, in order to fix it in its place, or to lower it in tempestuous weather, or when it is no longer necessary. The top-rope passes through a block which is hooked on one side of the cap, and afterwards through a hole furnished with a sheave on the lower end of the top-mast; it is then brought upwards on the other side of the mast, where it is fastened to an eye-bolt in the cap. To the lower end of the top-mast top-rope is fixed a tackle. See the article Top-Tackle. *Top-Rope*, is also the name of a rope used in swaying up or lowering down the top-gallant-yards.

Top-*Sails*, large sails extending across the top-masts by the top-sail yards above, and by the lower-yards beneath, being fastened to the former by earings and robands, and to the latter by means of the top-sail sheets, which passing through two great blocks fixed on its extremities, and from thence to two other blocks fixed on the inner part of the yard close by the mast, lead downwards to the deck.

Top-*gallant-Sails*, are extended above the top-sail-yards, in the same manner as the top-sails are extended above the lower-yards. See the article Sail.

Top-*Tackle*, a large tackle hooked to the lower end of the top-mast top-rope, and to the deck, in order to increase the mechanical power in hoisting the top-mast. It is composed of two strong iron-bound double or triple blocks, the hooks of which work on a swivel.

*Laying* Top, a cylindrical piece of wood, having three or four scores or notches on its surface, used in rope-making, and varying in its size according to the thickness of the rope for which it is intended.

TOPAZ. The name topaz has been restricted by Mr. Hauy to the stones called by mineralogists occidental ruby, topaz, and sapphire; which, agreeing in their crystallization, and most of their properties, were arranged under one species by Mr. Rome de Lisle, The topaz is found in Saxony, Bohemia, Siberia, and Brazil, mixed with other minerals in granite rocks. The Siberian and Brazil topaz, when heated, become positively electrified on one side and negatively on the other. It is infusible by the blow-pipe. The yellow topaz of Brazil becomes red when exposed to a strong heat in a crucible; that of Saxony becomes white by the same process. This shews us that the colouring matter of these two stones is different.

TOPOGRAPHY, a description or draught of some particular place or small tract of land, as that of a city or town, manor or tenement, field, garden, house, castle, &c. such as surveyors set out in their plots, or make draughts of, for the information and satisfaction of the proprietors.

TOPPING, the act of pulling one of the extremities of a yard higher than the other, by slackening one of the lifts and pulling up the opposite one, so as to place the yard at a greater or lesser distance obliquely with the mast.

Topping *Lift*, a large and strong tackle employed to suspend or top the outer end of a gaff, or of the boom of a cutter, brig, sloop, or schooner's main-sail.

Top *Men*, persons stationed in the several tops to attend the taking in or setting of the upper sails.

TORMENTOR, an instrument much used in tillage, sometimes for breaking down the stiff clod, and at other times for skimming off the surface turf, that it may be prepared for being burnt. It bears in general appearance some resemblance to a harrow, only it is supported on wheels, and each tine is furnished with a hoe or share that enters and cuts up the ground.

TORNADO, a sudden and vehement gust of wind from all points of the compass, frequent on the coast of Guinea. A tornado seems to partake much of the nature of a whirlwind, or perhaps of a water spout, but is more violent in its effects. It commences very suddenly, several clouds being previously drawn together, when a spout of wind proceeding from them strikes the ground in a round spot of a few rods or perches diameter, and proceeds thus half a mile or a mile. The proneness of its descent makes it rebound from the earth, throwing such things as are moveable before it, but some sideways or in a lateral direction from it. A vapour, mist, or rain, descends with it, by which the path of it is marked with wet. The following is a description of one which happened a few years since at Leicester, about 50 miles from Boston in New England; it happened in July, on a hot day, about four o'clock in the afternoon. A few clouds having gathered westward and coming overhead, a sudden motion of their running together in a point being observed, immediately a spout of wind struck the ground at the west end of a house, and instantly carried it away with a negro man in it, who was afterwards found dead in the path of it. Two men, and a woman, by the breach of the floor, fell into the cellar; and one man was driven forcibly up into the chimney-corner. These were preserved, though much bruised; they were wet with a vapour or mist, as were the remains of the floor, and the whole path of the spout. This wind raised boards, timbers, &c. A joist was found on one end, driven nearly three feet into the ground. The spout probably took it in its elevated state, and drove it forcibly down. The tornado moved with the celerity of a middling wind, and constantly declined in strength till it entirely ceased.

TORRID Zone, among geographers, denotes that tract of the earth lying upon the equator, and on each side as far the two tropics, or 23° 28′ of north and south latitude. The torrid zone was believed by the ancients to be uninhabitable, but is now well known to be even tolerable to the people of the colder climates, towards the north and south; the excessive heat of the day being there tempered by the coldness of the night.

TORTOISE SHELL, the shell of the testaceous animal called a tortoise; used in inlaying, and in various other works, as for snuff-boxes, combs, &c.

Toss (To) *the Oars up*, is to put them in a perpendicular direction, ready to let them all fall at once into the water, and is intended as a compliment to the passengers in the boat.

TOUCAN, in Astronomy, a constellation of the southern hemisphere, consisting of eight small stars, and otherwise called Anser Americanus.

TOUCH, or Feeling, *Sense of.* The sense of feeling differs from the other senses in belonging to every part of the body, external or internal, to which nerves are distributed. The term *touch* is most correctly applied to the sensibility which is diffused over the surface of the body. Touch exists with the most exquisite degree of sensibility at the extremity of the fingers and thumbs, and in the lips. The sense of touch is thus very commodiously disposed, for the purpose of encompassing smaller bodies, and for adapting itself to the inequalities of larger ones. The sensations acquired by the sense of feeling are those of heat, hardness, solidity, roughness, dryness, motion, distance, figures, &c. and all those corporeal figures which arise from a healthy or diseased state of the nerves, and the part of the body to which they belong. The pains of this sense are more numerous and vivid than those derived from any other sense; and therefore the relicts of them coalescing with one another, constitute the greatest share of our mental pains, that is, pains not immediately derived from sensation. On the other hand, its pleasures being faint and rare in comparison with others, and particularly those of the taste, have but a small share in the formation of the mental pleasures.

Touch-*Needle*, among assayers, refiners, &c. little bars of gold, silver, and copper, combined together in all the different proportions and degrees of mixture; the use of which is to discover the degree of purity of any piece of gold or silver, by comparing the mark it leaves on the touchstone with those of the bars.

TOUCH *and* Go, is spoken of a ship when under sail she rubs against the ground with her keel without much diminution of her velocity.

TOUCHING, is the state of a ship's sails when they first begin to shiver with their edges in the direction of the wind. It is either occasioned by an alteration in the ship's course, or by a change of the wind. See the article Full and By.

Touching *At*, implies the circumstance of stopping or anchoring occasionally at some intermediate port in the course of the voyage.

TOURMALINE, in Mineralogy, a species of siliceous earth, The thickest parts are opake; the thin, more or less transparent.

TOURNIQUET, a machine or instrument employed in the practice of surgery to stop bleeding. It can, however, only be applied to the limbs, and its use is only intended to be temporary.

Tow, (To) to draw a ship or boat forward in the water, by means of a rope attached to another vessel or boat, which advances by the effort of rowing or sailing. Towing is either practised when a ship is disabled, and rendered incapable of carrying sail at sea; or when her sails are not fixed upon the masts, as in a harbour; or when they are deprived of their force of action by a cessation of the wind. When a ship of war is dismasted, or otherwise disabled from carrying sail at sea, she is usually towed by a cable reaching from her bow to another ship ahead. In a harbour, towing is practised by one or more boats, wherein all the force of the oars is exerted to make her advance.

*To take a vessel in* Tow, is sometimes a figurative expression for taking care of her.

TOWING *over Board*, implies the act of drawing any thing after a ship or boat when she is sailing or rowing, which has previously been on board that ship or boat.

Tow-*Line*, a small hawser generally used to remove a ship from one part of a harbour or road to another by means of anchors, capstans, &c. See the article Warping. It is also employed occasionally to moor a small vessel in a harbour conveniently sheltered from the wind and sea.

Tow *Rope*, a name given to any cable or other rope used in the exercise of towing,

TOWER, any high building raised above another, consisting of several stories, usually of a round form, though sometimes square or polygonal; a fortress, a citadel. Towers are built for fortresses, prisons, &c. as the tower of the Bastile, which was destroyed by the inhabitants of Paris in 1789.

TOXICODENDRON, the poisonwood.

TRACHEOTOMY, in Surgery, is the operation of making an opening into the windpipe.

TRACK *of a Ship*. See the article Wake.

TRACKING, the act of pulling any vessel or floating body along the stream of a canal or river, by means of a rope extending from the vessel, &c. to an adjacent shore, and drawn along the banks of a river by men or horses. Whence

Track *Schuyt*, a vessel employed to carry goods and passengers up and down the rivers and canals in Holland, and the countries bordering on the Baltic sea.

TRADE, the practice of exchanging goods, wares, money, bills, and other articles of value, with the view of advantage or profit. It is generally distinguished into foreign trade, or the export and import of commodities to and from other countries. and the internal or home trade, or that which is carried on within the country; which two branches, however, are rather distinct in appearance than reality; for a very considerable portion of the internal trade arising from manufactures carried on to supply foreign markets, could not subsist without foreign commerce; while a large part of the returns for manufactures sent abroad, being articles for consumption or raw materials, which are converted to use in the different manufactures, depends upon our internal trade; so that the one supports the other, and by their mutual connexion and dependence, the foreign and the domestic trade of Great Britain have risen together to their present unparalleled height.

TRADE, implies the constant destination of any particular merchant vessel, as the Lisbon trade, West India trade, &c.

Trade *Winds*, certain regular winds blowing within or near the tropics, and being either periodical or perpetual. Thus, in the Indian ocean they blow alternately from two opposite points of the compass, and in the Atlantic ocean continue almost without intermission in one direction; see the article Wind.

TRAGACANTH, Gum, or, as some call it, *gum adragant*, or *gum dragon*, is the produce of the above and some other shrubs. The gum is brought to us in long and slender pieces, of a flatted figure more or less, and these not straight, or rarely so, but commonly twisted and contorted various ways, so as to resemble worms. We sometimes meet with it, like the other vegetable exudations, in roundish drops, but these are much more rare. It is moderately heavy, of a firm consistence, and, properly speaking, very tough rather than hard; and is extremely difficult to powder, unless first carefully dried, and the mortar and pestle kept dry. Its natural colour is a pale white, and in the cleanest pieces it is something transparent. It is often, however, met with of a brownish tinge, and of other colours still more opake. It has no smell and very little taste, but what it has is disagreeable. Taken into the mouth, it does not grow clammy and stick to the teeth, as the gum arabic does, but melts into a kind of very soft mucilage. It dissolves in water but slowly, and communicates its mucilaginous quality to a great quantity of that fluid. It is by no means soluble in oily or spirituous liquors, nor is it inflammable. It is brought to us from the island of Crete, and from several parts of Asia. It is to be chosen in long twisted pieces, of a whitish colour, very clear, and free from all other colours; the brown, and particularly the black, are wholly to be rejected.

TRAGEDY. *See* Poetry.

TRAIN, the hinder part of a gun carriage; also a line of gunpowder or other combustible materials, forming a communication with any body intended to be set on fire or exploded.

Train *Tackle*, a combination of pulleys which during action is locked to an eye-bolt in the train of the carriage, and to a ring-bolt in the deck. Its use is to prevent the gun from running out of the port whilst loading.

TRAJECTORY, a term often used, generally for the path of any body moving, either in a void, or in a medium that resists its motion, or even for any curve passing through a given number of points.

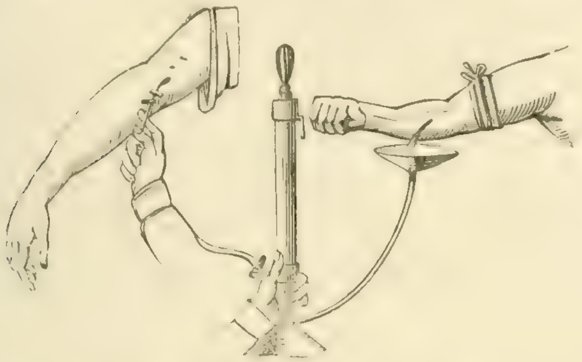
TRAMMELS, in Mechanics, an instrument used by artificers for drawing ovals upon boards, &c. One part of it consists of a cross with two grooves at right angles; the other is a beam carrying two pins, which slide in those grooves, and also the describing pencil.

TRAMMEL NET, is a long net wherewith to take fowl by night in champaign countries, much like the net used for the low-bell, both in shape, size, and meshes. To use it, they spread it on the ground, so that the nether or further end, fitted with small plummets, may lie loose thereon; then the other part being borne up by men placed at the fore ends, it is thus trailed along the ground. At each side are carried great blazing lights, by which the birds are raised, and as they rise under the net they are taken.

TRANSCENDENTAL, or Transcendent, something elevated or raised above other things, which passes and transcends the nature of other inferior things. Transcendental quantities, among geometricians, are indeterminate ones, or such as cannot be fixed, or expressed by any constant equation; such are all transcendental curves which cannot be defined by any algebraic equation, or which, when expressed by an equation, one of the terms thereof is a variable quantity.

TRANSFUSION of Blood. The experiments of Dr. Blundell and other experienced physiologists had long since demonstrated the practicability of transmitting blood from one living body to another; but it is, at length, to Dr. Blundell's application of it to the human body, and to his unwearied zeal and physiological knowledge, that the profession is indebted for positive data upon which it can be undertaken with the best hopes of saving life under circumstances of appalling, but, alas! frequent occurrence. The value of the operation having been lately demonstrated by several successful cases, there seemed to be wanting but one requisite for extending the benefit of this invaluable discovery into the remotest regions of professional influence. The extreme caution practised and inculcated by Dr. Blundell, shewing the danger of admitting air into the blood-vessels, sufficiently attests the necessity for an apparatus by which the operation may be conducted without incurring this risk. This has been supplied by an appendage which Mr. Read has added to his surgical syringe, and of which Dr. Blundell has been pleased to express his approbation. It consists of a double apparatus, the one receiving the blood into a tubulated funnel, the other transmitting it from the vein of one person into that of another, *without atmospheric communication.* In neither case is it necessary to lay bare the vein, as has been usually done, the venous pipes being constructed to pass freely into the opening made by the lancet. The transfusion appendages are so small, that the parts for the two modes of operating scarcely occupy the space of a common scalpel case, and, if fitted up with the stomach and enema apparatus, will increase the size in a very trifling degree.

*Directions for the Operation with Read's Apparatus.*—The metallic stem to be first screwed into the stand, the funnel next upon the stem, and, thirdly, the perpendicular arm of the latter to be inserted firmly into the extremity of the syringe by a rotatory twist. The flexible tube to be then screwed to the lateral branch of the syringe, and the silver pipe inserted into the socket at the other extremity. The apparatus being thus adjusted, the surgeon should pump a few ounces of water through it, keeping the point of the pipe immersed in the fluid, when, if he observes any bubbles of air rise, he must fix the different parts closer until no air is admitted. The whole should now be plunged into a basin of warm water for a minute or two, and being placed betwixt the person who supplies the blood and the patient, a ligature is to be put around the arm, and the blood drawn by a free incision into the funnel. An opening being made into a vein of the patient's arm, (the limb kept steady and unmoved, to preserve the relative position of the internal and external openings, as well as to prevent the cellular tissue from slipping over the orifice in the vein) the operator gives three or four short strokes of the piston, which expels the small quantity of air contained in the tube, without occasioning the expenditure of more than a few drachms of blood. The pipe is to be immediately introduced into the vein, and the shield pressed against the surface of the arm by the fingers of an assistant, whilst the operator proceeds to throw in the blood by jets. Dr. Blundell recommends the piston to be drawn up only one-fourth its length, which will be found to throw in about a drachm of blood at a stroke. The surface of the blood in the funnel must not be allowed to sink below a line drawn in the lower part of its interior, lest air should be admitted with the fluid.



To convey blood from one person to another without atmospheric communication, the tube with the cylindrical socket, being armed with a silver pipe, is to be inserted into the extremity of the syringe, and the pipe passed into a vein (in the direction of the fingers) of the right arm of the person who is to furnish it, and whose arm is to be tied up as in the former case. A few strokes of the piston (as before directed) throws out a small quantity of blood, and expels the air in the tubes, when the pipe of the tube screwed to the side-branch of the syringe is to be passed into a vein (in the direction of the heart) of the left arm of the patient, and the quantity of blood injected may be measured by counting the strokes of the piston, reckoning one drachm at each jet. The patient should recline upon the back, with the left arm near the edge of the bed; the person losing the blood should sit on a *very low* seat close to the bedside and with his back to the operator, who stands with the pump in his left hand sufficiently distant from both parties to keep the tubes as nearly straight as possible, one nearly horizontal, the other almost perpendicular. The syringe should be very clean when used, and the assistants are required to keep the pipes firmly in the veins, during the operation.

**TRANSIT**, in Astronomy signifies the passage of any planet just by or over a fixed star, or the sun; and of the moon in particular covering or moving over any planet.

**TRANSITION**, in Music, the softening a distinct interval by the introduction of intermediate sounds. In harmony, transition is the changing the genus or mode in a sensible but regular manner.

**Transition** *Rocks*, are particularly distinguished as being the lowest in which fossil remains of animals or vegetables are found; they may be regarded as ancient records imprinted with the natural history of the first inhabitants of the globe.

**TRANSMUTATION**, in Geometry, denotes the reduction or change of one figure or body into another of the same area or solidity, but of a different form; as, a triangle into a square, a pyramid into a parallelopiped, &c. In the higher geometry, transmutation is used for the converting a figure into another of the same kind and order, whose respective dimensions in an equation admit of the same tangents, &c. In alchemy and metallurgy, transmutation signifies the turning of one metal into another, so as entirely to change its nature.

**TRANSOMS**, certain beams or timbers extended across the sternpost of a ship, to fortify her after-part, and give it the figure most suitable to the service for which she is calculated.

*Helm-port* **Transom**, that which is at the head of the sternpost, and forms the upper part of the gun-room ports.

*Wing* **Transom**, the next below, and forming the lower-part.

*Deck* **Transom**, that whereon all the lower deck planks are rabbeted. The 1st, 2nd, 3d, transoms, &c. are respectively below the preceding.

**Transom** *Knees*, are strong pieces of curved timber, which connect the ship's quarter to the transoms, being bolted to the latter and to the after timbers. *See* Knees.

**TRANSOM**, among Builders, denotes the piece that is framed across a double light window.

**Transom**, among Mathematicians, signifies the vane of a cross-staff, or a square whereon it slides, &c.

**TRANSPARENCY**, a quality in certain bodies, by which they give passage to the rays of light.

**TRANSPORT.**—*See* Ship.

**Transport** *Office*, a department under government directed by commissioners, who charter vessels and appoint officers for the conveying troops to or from this country; they are also to provide accommodation and provision for all prisoners of war, to regulate their exchange by cartel, &c.

*To* **Transport** *a Ship*, is to move her by means of hawsers, anchors, &c. from one part of a harbour to another.

**TRANSPORTATION**, the act of conveying or carrying a thing from one place to another.

**Transportation**, is a kind of punishment, or more properly an alleviation or commutation of punishment, for criminals convicted of felony; who for the first offence, unless it is an extraordinary one, are generally transported to the plantations, (at present to New South Wales), there to bear hard labour for a term of years, within which if they return, they are executed without further trial than identifying their persons.

**TRANSPOSITION**, in Algebra, the bringing any term of an equation over to the other side.

**TRANSUBSTANTIATION**, in Theology, the conversion or change of the substance of the bread and wine in the eucharist, into the body and blood of Jesus Christ, which the Romish church holds is wrought by the consecration of the priest. This is a main point in the Romish religion, and is rejected by the Protestants, the former maintaining the transubstantiation to be real, the latter only figurative; interpreting the text, *Hoc est corpus meum*, "this signifies my body;" but the council of Trent stood up strenuously for the literal sense of the verb *est*, and say expressly that in transubstantiation the body and blood of our Lord Jesus Christ are truly, really, and substantially, under the species of bread and wine.

**TRANSVERSE** Muscles, in Anatomy, are certain muscles arising from the transverse processes of the vertebræ of the loins.

**TRAP**, is derived from the Swedish word trappa, a stair. It is applied, in geology, chiefly to such rocks as are frequently seen rising in regular order above one another in the form of stairs, as basalt. The chief trap rocks are horne blende, which is subdivided into granular hornblende, and hornblende slate. There is also hornblende mixed with felspar, of which greenstone and greenstone slate are common subdivisions. Also hornblende mixed with mica. The transition trap consists of greenstone and amygdaloed.—Trap also signifies a snare, contrived to catch men, animals, birds, &c.

**TRAPEZIUM**, in Geometry, a plane figure contained under four unequal right lines.

**TRAVELLER**, one or more iron thimbles, with a rope spliced round them, sometimes forming a kind of tail, but more generally a species of grommet, and used on various occasions.

**TRAVELLING Back Stays**, are so denominated from their having a traveller upon the top-mast, which slides down as the top-sail is lowered, thereby confining the principal support of the back-stay to that part of the mast immediately above the top-sail-yard. *See* Backstay.

Travelling *Martingale*, a similar contrivance adapted to a martingale, to support the jib-boom in that particular part where the jib-tack is fixed. *See* Martingale.

**TRAVERSE**, or Transverse, in general denotes something that goes athwart another; that is, crosses, and cuts it obliquely.

Traverse, in Law, signifies sometimes to deny, sometimes to overthrow or undo a thing, or to put one to prove some matter; much used in answer to bills in chancery: or it is that which the defendant pleads or says in bar, to avoid the plaintiff's bill either by confessing and avoiding, or by denying and traversing the material part thereof.

Traverse *an Indictment*, is to take issue upon the chief matter, and to contradict or deny some point of it. A traverse must be always made to the substantial part of the title. Where an act may indifferently be intended to be at one day or another, there the day is not traversable.

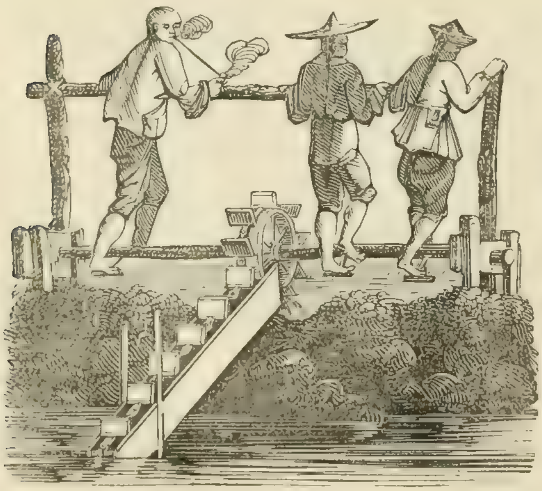
**TRAVERSE Sailing**, is used when a ship having set sail from one port towards another, whose course and distance from the port sailed from is given or known, is by reason of contrary winds, or other accidents, forced to shift and sail on several courses, which are to be brought into one course, to learn after so many turnings and windings the true course and distance made from the place sailed from, and the true point or place where the ship is; that so, the wind coming fair, it may be known how afterwards to shape a course for the place intended. This may be performed geometrically two ways; the first by drawing new meridians through the extremity of every course, parallel to the first meridian, or north and south line, at first made, and setting off every course at sixty, as if it were a question in plain sailing; you may also let fall perpendiculars to every new meridian, from the point that the ship sailed to upon that course; by which you have the course, distance, difference of latitude, and departure, to every course. To work a traverse by the tables of difference of latitude and departure, make a little table with six columns; the first for the course, the second for the distance, the third for the northing, the fourth for the southing, the fifth for the easting, and the sixth for the westing. Then find the difference of the latitude and the departure to every course, and set them in their proper columns; as where the course is northerly, set the difference of latitude under northing, or in the north column; and where the course is southerly, set the difference of latitude in the south column. Again, where the column is easterly, set the departure in the east column, and when westerly set it in the west column; then adding up each column by itself, subtract the north and south columns, the less from the greater, the remainder is the northing or southing made good; then have you the difference of latitude and the departure, given to find the course and distance. This is the principal use those tables are intended for, and the way of working a traverse hereby is equal to the best for exactness, and superior in point of expedition.

Traverse *Board*, a thin circular piece of board, marked with all the points of the compass, and having eight holes bored in each, and eight small pegs hanging from the centre of the board. It is used to determine the different courses run by a ship during the period of a watch, which is performed by sticking one peg into the point on which the ship has run each half hour. This implement is particularly useful in light and variable winds.

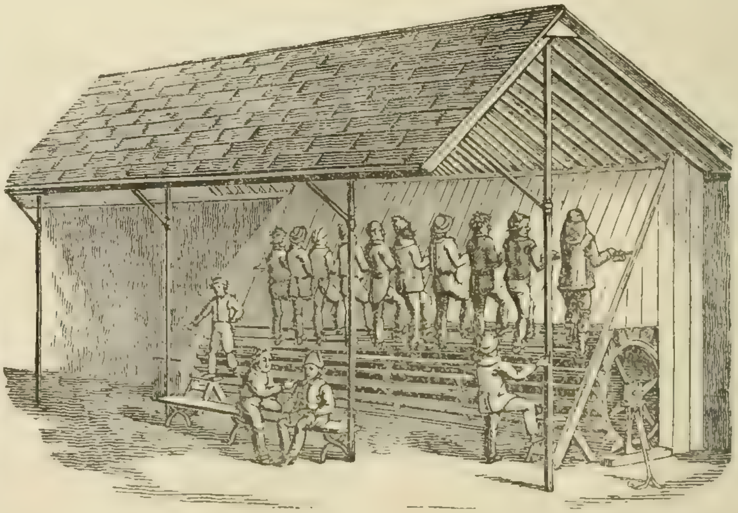
Traverse *Table*, is the same with a table of difference of latitude and departure, being only the difference of latitude and departure ready calculated to every degree, point, half point, and quarter point of the quadrant; and for any distance under one hundred miles, though it may conveniently serve for greater distances, by taking their halves, thirds, fourths, &c. and doubling, tripling, and quadrupling, &c. the difference of latitude and departure found to those parts of the distance. This table is one of the most necessary things a navigator has occasion for; for by it he can readily deduce all his courses and distances run in the space of twenty-four hours, into one course and distance; whence the latitude he is in, and his departure from the meridian, may be found.

**TREADMILL.** This is an invention of the Chinese, and is used to raise water for the irrigation of the fields. Culprits are condemned to this labour, the mode of working is very simple, and will be seen by looking at the figure. The treadmill lately introduced into the prisons in Great Britain is of a more complicated construction. It is the invention of Mr. Cubitt, of Ipswich. The engraving exhibits that erected at Brixton. This wheel is exactly similar to a common water-wheel; the tread-boards upon its circumference are, however, of considerable length, so as to allow sufficient standing room for a row of from ten to twenty persons upon the wheel. Their weight, the first moving power of the machine, produces the greatest effect when applied upon the circumference of the wheel at or near the level

*Chinese Tread Mill.*



*English Tread Mill.*



of its axle; to secure therefore this mechanical advantage, a screen of boards is fixed up in an inclined position above the wheel, in order to prevent the prisoners from climbing or stepping up higher than the level required. A hand rail is seen fixed upon this screen, by holding which they retain their upright position upon the revolving wheel; the nearest side of which is exposed to view in the plate, in order to represent its cylindrical form much more distinctly than could otherwise have been done. In the original, however, both sides are closely boarded up, so that the prisoners have no access to the interior of the wheel, and all risk of injury whatever is prevented.—By means of steps, the gang of prisoners ascend at one end; and when the requisite number range themselves upon the wheel, it commences its revolutions. The effort then to every individual is simply that of ascending an endless flight of steps, their combined weight acting upon every successive stepping board, precisely as a stream of water upon the float boards of a water-wheel. During this operation each prisoner gradually advances from the end at which he mounted towards the opposite end of the wheel, from whence the last man taking his turn descends for rest (see the engraving), another prisoner immediately mounting as before, to fill up the number required, without stopping the machine. The interval of rest may then be proportioned to each man by regulating the number of those required to work the wheel with the whole number of the gang; thus, if twenty out of twenty-four are obliged to be upon the wheel, it will give to each man intervals of rest amounting to twelve minutes in every hour of labour. Again, by varying the number of men upon the wheel, or the work inside the mill, so as to increase or diminish its velocity, the degree of hard labour or exercise to the prisoner may also be regulated. At Brixton, the diameter of the wheel being five feet, and revolving twice in a minute, the space stepped over by each man is 2193 feet, or 731 yards per hour. At page 324 the reader will find a description and engraving of another species of treadmill.

**TREASON**, in Law, is divided into high treason and petty treason. High treason is defined to be an offence committed against the security of the king or kingdom, whether it be by imagination, word, or deed; as, to compass or imagine the death of the king, queen, or prince, or to deflower the king's wife, or his eldest daughter unmarried; or his eldest son's wife; or levy war against the king in his realm, adhere to his enemies, counterfeit his great seal, privy seal, or money, or wittingly to bring false money into his realm counterfeited like the money of England, and utter the same, to kill the king's chancellor, treasurer justices of either bench; justices in eyre, of assize, or of oyer and terminer, being in their place doing his office, forging the king's sign manual or privy signet, privy seal or foreign coin current here, or diminishing or impairing current money. In this case of treason, a man shall be hanged, drawn, and quartered, and forfeit his lands and goods to the king. 25 Ed. III.

**Treason**, *Petit.* Whenever a wife murders her husband, a servant his master or mistress, or an ecclesiastic a prelate, or to whom he owes obedience, every one of these offences is petit treason.—As every petit treason implies a murder, it follows, that the mere killing of a husband, master, or prelate, is not always petit treason; for if there are not such circumstances in the case of killing one of these persons as would have made it murder in the case of killing any other person, it does not amount to this offence. There can be no accessary in high treason. And it seems to be always agreed, that what would have made a man an accessary before the fact in any other felony, makes him a principal in high treason.

**TREASURE Trove**, is where any money or coin, gold, silver, plate, or bullion, is hidden in the earth, or other private place, the owner being unknown; in which case the treasure belongs to the king, or some other who claims by the king's grant or by prescription. But if he that hid it is known or afterwards found out, the owner and not the king is entitled to it. If it is found in the sea or upon the earth, it does not belong to the king, but to the finder if no owner appear.

**TREASURER**, an officer to whom the treasure of a prince or corporation is committed to be kept, and duly disposed of.

**TREATY**, a covenant between several nations, or the several articles or conditions stipulated and agreed upon between sovereign powers.

**TREE**, the first and largest of the vegetable tribe, consisting of a trunk, out of which spring forth branches and leaves.

**TREE-NAILS**, certain long cylindrical wooden pins, employed to connect the planks of the ship's side and bottom to the corresponding timbers, and are justly esteemed superior to spike nails or bolts, which are liable to rust and loosen; the thickness of the tree-nails is usually proportioned to the length of the ship, allowing one inch to every hundred feet.

**TREFOIL**, in Architecture, is the ornamenting of an arch in a particular manner. In Agriculture, trefoil is a valuable grass very generally cultivated.

**TRENCHES**, in Fortification, are ditches cut by the besiegers, that they may approach more securely to the place attacked, whence they are also called lines of approach. The tail of the trench is the place where it was begun, and its head is the place where it ends. The trenches are usually begun or opened in the night time; sometimes within musket-shot, and sometimes within half or whole cannon shot of the place. They are carried on in winding lines, nearly parallel to the works of the fortress, so as not to be in the view of the enemy, nor exposed to the enemy's shot. The workmen employed in the trenches are always supported by a number of troops, to defend them against the sallies of the besieged: the pioneers sometimes work on their knees, and are usually covered with mantlets or faucissons; and the men who support them lie flat on their faces, in order to avoid the enemy's shot.

**TREND**, (To) to incline, speaking of a coast, as, "The land trends to the south-west."

**TREPAN**, in Surgery, a circular saw, by means of which the operation called trepanning is performed. It bears a strong resemblance to a whimble or centre bit, and is worked in an almost similar manner.

**TRESPASS**, is any transgression of the law, under treason, felony, or misprision of either.

**TRESTLE Trees**, two strong bars of timber fixed horizontally on the opposite sides of the lower-mast head, to support the frame of the top and the weight of the top-mast.

**TRET**, in Commerce, an allowance made for the waste or the dirt that may be mixed with any commodity, which is always four pounds in every hundred and four pounds weight.

**TRIAL**, the proceeding of a court of law when the parties are at issue, such as the examination of witnesses, &c. to enable the court, deliberately weighing the evidence given on both sides, to draw a true conclusion, and administer justice accordingly.

**TRIANGLE**, in Geometry, a figure bounded or contained by three lines or sides, and which consequently has three angles from whence the figure takes its name.

**TRIANGULA**, *The Triangles.* The poets feign that Jupiter assigned the island of Sicily a place in the heavens, under the figure of a triangle. Hevelius has added to Jove's labour by introducing another triangle in this asterism. The old triangle is also said to owe its origin to the Delta in Egypt; both of these figures are easily distinguished by the stars on which they are formed, as well as their position relatively to Andromeda, Cepheus, and Aries.—*Boundaries and Contents.* North by Andromeda, west by Andromeda and Pisces, south by Aries, and east by Musca and Perseus. There are sixteen stars in this constellation, three of which are of the fourth magnitude and the remainder of inferior magnitudes.

**TRIANGULAR Compasses**, are such as have three legs or feet whereby to take off any triangle at once, much used in the construction of maps, globes, &c.

**Triangular** *Numbers*, are a kind of polygonal numbers, being the sums of arithmetical progressions which have 1 for the common difference of their terms. Thus, from these arithmeticals, 1, 2, 3, 4, 5, 6, are formed the triangular numbers, 1, 3, 6, 10, 15, 21, or the third column of the arithmetical triangle above mentioned.

**Triangular** *Canon*, the tables of artificial sines, tangents, secants, &c.

**Triangular** *Quadrant*, is a sector furnished with a loose piece whereby to make it an equilateral triangle. The calendar is graduated thereon with the sun's place, declination, and other useful lines; and by the help of a string and a plummet, and the divisions graduated on the loose piece, it may be made to serve for a quadrant.

TRIANGULUM AUSTRALE, the *Southern Triangle*, one of the constellations situated on the Antarctic circle, contains five stars, *viz.* one of the 2d magnitude, two of the 3d, &c.

TRIBOMETER, an instrument invented for estimating the friction of metals.

TRICE, (To) to haul or tie up by means of a small rope or line.

TRICHECHUS, WALRUS, a genus of quadrupeds of the order bruta. It is principally found in the high latitudes of the northern ocean. These animals are gregarious, and are often seen upon floating masses of ice in immense numbers, the greater part sleeping, but some always on the watch to give notice of approaching danger. They are harmless when not provoked, but some accounts represent them as highly formidable in a state of irritation, the efforts of many being combined against the enemy, and fastening with their teeth against the boats, to make holes in them, or draw them to the bottom. Others represent them as less agitated by the fury of passion, and as inclined more to flight than revenge; adding, that they are terrified by the slightest flash, and even the pointing of a musket will drive them in a moment out of sight. Their tusks serve the purposes of aiding their movements upon the ice, into which they are stuck, and on which they thus secure their hold, and sometimes drag on their unwieldy bodies. The tusks are convertible to the purposes of ivory, and these animals are destroyed for the profit derived parly from these tusks, but principally for the sake of their oil, of which a full-grown walrus will yield a butt. The skin may be manufactured into a very strong leather. The affection between the female and its young one, for it has seldom more than one at a birth, is such, that they are said never to separate, and that when one is killed, the survivor refuses to quit the dead body, and is considered by the hunter as his secure prey. The walrus has been called, with little resemblance to justify the name, the sea-horse; it is more similar to a cow—but most of all to a seal. The whale-tailed manati, inhabits the seas between Kamptschatka and America. These animals live in families, generally consisting of a male and female, and two young ones of different ages, and the attachment of the male to the female is so great, that he will defend her when attacked to the last extremity: and if she happens to be destroyed and dragged to the shore, he will swim for some days off the fatal and detested spot. The manati approaches very nearly to the cete tribe, and its feet are little more than pectoral fins. It attains the immense length of twenty-seven feet, and the weight of four tons. In winter it is extremely lean, and its ribs may be distinctly numbered. It will, when pierced with the harpoon, sometimes adhere to rocks with its feet with uncommon tenacity, and when forced from them by a cord drawn by thirty men or more, is found to have left part of the skin of the feet behind. When any individual is harpooned, others are stated to swim to its aid, endeavouring some to overturn the boat, others to break the cord, and others again by blows with their tails striving to dislodge the harpoon. Their sounds resemble the snorting of a horse. They are never seen on land.

TRICING LINE, a small cord generally passing through a block or thimble, and used to hoist up any object to a higher station, in order to render it less inconvenient, such are the tricing lines of the yard tackles, &c.

TRICK, the same as spell with regard to steering the ship. See the article SPELL.

TRIFOLIUM, TREFOIL, or *Clover*, a genus of plants of the class diadelphia, and order decandria, and in the natural system ranging under the 32d order papilionaceæ. The flowers are generally in round heads; the pod is scarcely longer than the calyx, univalve, not opening, deciduous. The leaves are three together: 51 species.

TRIGONOMETRY. The business of this important science is to find the angles, where the sides are given; and the sides of their respective ratios, when the angles are given; and to find sides and angles, when sides and angles are partly given. To effect this, it is necessary not only that the peripheries of circles, but also certain right lines in and about circles, be supposed divided into certain numbers of parts. The ancients, feeling the necessity of such a pre-division, portioned the circles into 360 equal parts, which they called degrees; each degree was again divided into 60 equal parts, called minutes; and each minute comprised 60 equal parts called seconds. The moderns have improved upon this division by the addition of a nonius, or vernier, which may be carried to any extent, but is usually limited to decimating the seconds; noting each tenth part thereof. It would have been found a considerable convenience in mathematics, if the circle had been divided into centesimal parts, particularly in trigonometrical operations; thus making every quadrant to consist of 100 degrees, each degree of 100 minutes, and each minute of 100 seconds; there can, indeed, be no doubt that all the arithmetical calculations relating to the periphery, as well as to the secants, signs, tangents, radii, chords, and complements, would by this reformation have been simplified. See the words MENSURATION, ACCESSIBLE DISTANCE, HEIGHTS and DISTANCES, &c.

TRILLION, in Arithmetic, a billion of billions.

TRIM, the state or disposition of the ballast, cargo, masts, &c. by which a ship is best equipped for the several purposes of navigation.

*The* TRIM *of the Hold*, implies the arrangement of the materials therein, by which a ship is either brought by the head or stern, or depressed in the water to a sufficient depth to carry sail well, and advance rapidly. As the stowage of the hold, or the disposition of the several articles of the cargo, considerably affects the ship's motion and stability, it will be necessary to give a general idea of the action that supports it, and the reaction of the fluid on the floating body.

First, we may consider the whole weight of any body as united in its centre of gravity: so that if it were suspended by a line fastened to this centre, the line would hang in a perpendicular position, as directed through the centre of gravity to the centre of the earth. A body which floats in a fluid is not, however, supported by its centre of gravity, but by the compression of the surrounding filaments of water; and each of these being considered as infinitely small, will act upon a very minute portion of the surface of the floating body with regard to the specific gravity, and conform to a principle applicable to all fluids, in proportion to the height of these filaments, *viz.* that the weight of a column of any fluid will be in proportion to the specific gravity of the fluid and the height of the column multiplied by its base. But as heavy bodies endeavour by their gravity to approach the centre of the earth in a vertical line passing through their centres, so the pressure of fluids endeavours to carry bodies in a vertical line tending from the centre of the earth towards the surface, and passing through the centre of gravity of the submerged part which forces them towards the surface. So in any submerged body at rest, these two opposite forces coincide in the same vertical, acting in a direction quite contrary to each other. According to this theory, it appears that the stability or trim of a ship chiefly depends upon her construction, as considering the bottom to be homogeneous. This, however, can only happen when her cargo consists of the same materials throughout, as with corn, salt, or any species bestowed in bulk, and when her hold is entirely filled: for if the ship has not sufficient breadth to resist the effort of the wind upon her sails, or if she is built too high or too sharp in the floor, her gravity will be too high, and she will be very crank, *i. e.* apt to overturn. But as the stiffness of a ship, or quality to carry sail without damage of overturning, depends very much on the stowage of the hold, the centre of gravity may thereby be considerably lowered, by which her stability will be increased in proportion. It is a general maxim among mariners, that a ship will not carry sufficient sail till she is laden so deep that the surface of the water may glance on her extreme breadth amid-ships. She must therefore have a great deal of weight, as ballast, &c. to bring her to this situation, which is called a good sailing trim. With regard to the quality, weight, and stowage of the ballast, there are also several circumstances to be particularly considered. If the centre of gravity be placed too high, the ship will be rendered incapable of carrying a sufficient quantity of sail, and if it be placed too low, she will be in danger of rolling away her masts. When it is placed too far forward, the vessel will pitch and labour heavily; and when too far aft, she will occasionally be exposed to the dangerous circumstance of a pooping sea. These extremes being carefully avoided, it remains to proportion the contents of every part of the hold to its capacity, and to place the lightest materials uppermost.

Trim *of the Masts*, denotes their position with regard to the ship and to each other, whether near or distant, far forward or much aft, erect or raking.

Trim *of the Sails*, signifies the general arrangement which is best calculated to accelerate the ship's course according to the direction of the wind. See the articles Close-hauled, Large Sailing, Tacking, &c.

If a ship were always to sail before the wind, it would be a very simple operation to trim the sails; for nothing more would be required than to dispose them so as to receive the greatest possible effort of the wind, which is evidently performed by arranging them at right angles with its direction. But when the current of wind acts more directly upon the ship's side, it necessarily falls more obliquely on the surface of the sails, so as to diminish their effort to push the ship forward, and to augment their tendency to make her incline to one side. Hence we may conclude, that an increase of the wind, when accompanied with a variation unfavourable to the ship's course, will by no means augment her velocity; because the force previously employed to push her forward will afterwards operate to overturn her, and because this impression renders it necessary to reduce the quantity of sail; the effort of which is further diminished by the obliquity of the action of the wind upon its surface. By this theory it appears, that the effect of the wind to advance the ship, decreases in proportion to its obliquity with any sail upon which it operates.

Trim *the Boat. See* Boat.

**TRIMMED** Sharp, the situation of a ship's sails in a scant wind.

**TRINITY HOUSE**, a kind of college at Deptford, belonging to a company or corporation of seamen, who by the king's charter have power to take cognizance of those persons who destroy sea-marks, and to get reparation of such damages, and to take care of other things belonging to navigation. At present, many in the first rank of society are members of that community. The master, wardens, and assistants of the Trinity House, may set up beacons and marks for the sea, in such places near the coast or forelands as to them shall seem meet. By a statute of Queen Elizabeth, no steeple, trees, or other things standing as sea-marks, shall be taken away or cut down, upon pain, that every person guilty of such offence shall forfeit 100l. and if the person offending be not possessed of the value, he shall be deemed convicted of outlawry.

**TRIP**, a phrase implying an outward-bound voyage, particularly in the coasting navigation. It also denotes a single board in plying to windward.

**TRIPLICATE** Ratio, the ratio of cubes to one another.

**TRIPOLI**, a mineral found sometimes in an earthy form, but more generally indurated. Its texture is earthy.

**TRIPPING**, the movement by which an anchor is loosened from the bottom, either by its cable or buoy-rope.

Tripping-*Line*, a small rope serving to unrig the lower-top-gallant-yard-arm, when in the act of striking or lowering it down upon deck.

**TRISECTION**, or Trissection, the dividing a thing into three. The term is chiefly used in geometry for the division of an angle into three equal parts. The trisection of an angle geometrically, is one of those great problems whose solution has been so much sought by mathematicians for these two thousand years, being in this respect on a footing with the quadrature of the circle, and the duplicature of the cube angle.

**TRITICUM**, Wheat, a genus of plants of the class triandria, and order digynia, and in the natural system ranging under the fourth order gramina.

**TROCHILUS**, *Humming Bird*, a genus of birds belonging to the order of picæ. There are sixty-five species, none of which are natives of Britain: they are all remarkable for the beauty of their colours, and most of them for the smallness of their size, though some are eight or nine inches in length. They are divided into two families, *viz.* those with crooked bills, and those with straight bills.

**TRONAGE**, the mayor and commonalty of the city of London are ordained keepers of the beams and weights for weighing merchants' commodities, with power to assign clerks, porters, &c. of the great beam and balance, which weighing of goods and wares is called tronage.

**TROPHY**, Tropæum, among the ancients, a pile or heap of arms of a vanquished enemy, raised by the conqueror in the most eminent part of the field of battle. The trophies were usually dedicated to some of the gods, especially Jupiter. The name of the deity to whom they were inscribed was generally mentioned, as was that also of the conqueror.

**TROPICS**, two imaginary lines upon the globe parallel to the equator, and at 23½ degrees distance on each side of it; they form the boundaries of the sun's declination north and south.

**TROUGH**, a name given to the hollow or interval between two waves, which resembles a broad and deep trench perpetually fluctuating. As the setting of the sea is always produced by the wind, it is evident that the waves, and consequently the trough or hollow space between them, will be at right angles with the direction of the wind; hence a ship rolls heaviest when she lies in the trough of the sea.

**TROUT**, a very valuable river fish, too well known to need description.

**TROVER**, is the remedy prescribed by the law, where any person is in the possession of the property of another, which he unlawfully detains.

**TROY WEIGHT**, one of the most ancient of the different kinds used in Britain. The pound English troy contains 12 ounces, or 5760 grains.

Troy Weight, *Scots*, was established by James VI. in the year 1618, who enacted that only one weight should be used in Scotland, *viz.* the French troy stone of 16 pounds, and 16 ounces in the pound. The pound contains 7600 grains; and is equal to 17 oz. 6 dr. avoirdupois. The cwt. or 112 lb. avoirdupois, contains only 103 lb. 2½ oz. of this weight, though generally reckoned equal to 104 lb. Though prohibited by the articles of union, it is still used in weighing iron, hemp, flax, most Dutch and Baltic goods, meal, butcher's meat, unwrought pewter and lead, and some other articles.

**TRUCE**, in War, denotes a suspension of arms, or a cessation of hostilities between two armies, in order to settle articles of peace, bury the dead, or the like.

**TRUCKS**, pieces of wood of various forms, and used for different puposes, as

Trucks *of a Gun Carriage*. See the article Carriage.

Trucks *of the Mast-Head*, circular pieces of wood, fixed as a cap on the top-gallant-mast heads. They are generally furnished with two or more small pulleys through which the pendant and signal-halliards are reeved. They are also called acorns.

Trucks *of the Parrels*, are spherical pieces of wood, having a hole through them, in which is inserted the rope of the parrel. See the article Parrel.

Trucks *of the Flag Staff*, are pieces resembling an oblate spheroid.

Trucks *of the Shrouds*, or *Seizing Trucks*, are pieces something resembling those of the parrels, except that they are scored round the outside, to receive a seizing, and are fixed to the shrouds, in order to lead the running rigging and prevent it from hanging. The intention of these is to guide the sailors to the particular rope which, especially in the night, might otherwise be mistaken for some other of the same size.

**TRUFFLES**, in Natural History, a kind of subterraneous puff-ball, being a species of fungi, which grows under the surface of the earth.

**TRUMPET**, the loudest of all portable wind instruments, and consisting of a folded tube generally made of brass, and sometimes of silver.

Trumpet *Hearing*, is an instrument to assist the hearing of persons who are deaf. Instruments of this kind are formed of tubes, with a wide mouth, and terminating in a small canal, which is applied to the ear. The form of these instruments evidently shews how they conduce to assist the hearing, for the greater quantity of the weak and languid pulses of the air being received and collected by the large end of the tube, are reflected to the small end, where they are collected and condensed; thence entering the ear in this condensed state, they strike the tympanum with a greater force than they could naturally have done from the ear alone. Hence it appears that a speaking trumpet may be applied to the purpose of a hearing trumpet by turning the wind end towards the sound, and the narrow end to the ear.

Trumpet, *Marine*, a kind of monochord, consisting of three tables which form its triangular body. It has a very narrow neck, with one thick string, mounted on a bridge, which is firm on one side, and tremulous on the other. It is struck with a bow by the right hand, while the thumb of the left is pressed on the string.

Trumpet, *Speaking*, is a tube of considerable length, *viz.* from 6 feet to 12, and even more, used for speaking with, to make the voice heard to a greater distance. In a trumpet of this kind the sound in one direction is supposed to be increased, not so much by its being prevented from spreading all around, as by the reflection from the sides of the trumpet. The figure best suited for the speaking trumpet is that which is generated by the rotation of a parabola about a line parallel to the axis.

TRUNCATED, in general, is an appellation given to such things as have, or seem to have, their points cut off.

TRUNDLE, in rural economy, a sort of truck having two handles at one extremity, and two low wheels at the other, by which means it is trundled before the person using it. In conveying articles of great weight, but of small bulk, this simple machine is found very convenient.

Trundle *Shot*, an iron bar called a shot, about seventeen inches long, and sharp-pointed at the ends, having a round ball of lead cast upon it, at a hand's breadth from the extremities.

TRUNKS, Fire, wooden funnels fixed in fire-ships, under the shrouds, to convey the flames to the masts, rigging, and sails.

TRUNNIONS, the two knobs or arms which project from the opposite side of a piece of artillery, and serve to support it in the carriage.

TRUSS, is also used for a sort of bandage or ligature made of steel, or the like matter, wherewith to keep up the parts in those who have hernias or ruptures. A bale of goods is also called a truss.

Truss *of Flowers*, is used by florists to signify many flowers growing together on the head of a stalk, as in the cowslip, auricula, &c.

Truss, among Mariners, signifies a machine employed to pull a lower yard close to its mast, and retain it firmly in that position. As the truss is generally used instead of a parrel, it is rarely employed except in flying top-gallant sails, which are never furnished with parrels. It is no other than a ring or traveller, which encircles the mast, and has a rope fastened to its after-part, leading downward to the top or decks; by means of which the truss may be straitened or slackened at pleasure. The halliards of the top-gallant sails being passed through this ring, and the sail being hoisted up to its utmost extent, it is evident that the yard will be drawn close to the main-mast by pulling down the truss close to the upper part of the sail; for without the truss the sail and its yard would be blown from the mast so as to swing about by the action of the wind and the rolling of the vessel, unless the yard were hoisted close up to the pulley wherein the halliards run, which seldom is the case in flying top-gallant-sails, because they are usually much shallower than those which are fixed or standing.

Truss *Tackle*, a combination of pulleys fixed to the end of the truss pendants to bowse them taught.

TRUST, is a right to receive profits of land, and to dispose of the land in equity. And one holding the possession, and disposing of it at his will and pleasure, are signs of trust.

TRUSTEE, one who has an estate or money put or trusted in his hands for the use of another.

TRYING, the situation in which a ship lies nearly in the trough or hollow of the sea in a tempest, or it is the act of lying to in a storm, which may be performed under any of the courses reeved, if requisite, or even under bare poles, the helm being lashed a-lee. In trying, as well as in scudding, the sails are always reduced in proportion to the increase of the storm. Thus, in the former state a ship may lie by the wind under a whole main-sail, a whole fore-sail, or a whole mizzen; or under any of those sails, when diminished by the reef or balance. As the least possible quantity of sail used in scudding are the goose-wings of the fore-sail, so in trying, the smallest portion is generally the mizzen stay-sail, or main stay-sail; and, in either state, if the storm be excessive, she may lie with all the sails furled, or, according to the sea phrase, under bare poles. The intent of spreading a sail at this time is to keep the ship more steady, and by pressing her side down in the water, to prevent her from rolling violently, and also to turn her towards the direction of the wind, so that the shock of the waves may fall more obliquely on her flank than when she lies along the trough of the sea. While she remains in this situation, the helm is fastened close to the lee-side, or, in the sea language, hard a-lee, to prevent her as much as possible from falling off. But as the ship is not then kept in equilibrium by the effort of her sails, which at other times counterbalance each other at the head and stern, she is moved by a slow but continual vibration, which turns her head alternately to windward and to leeward, forming an angle of three or four points in the interval. That part where she stops in approaching the direction of the wind, is called her coming to, and the contrary excess of the angle to leeward is termed her falling off. Thus, suppose the wind northerly, and a ship trying with her starboard side to windward; if, in turning her head towards the source of the wind she arrives at N. W. ½ N. or N. 39° W. and then declines to the leeward as far as W. ½ S or S. 84° W. the former will be called her coming to, and the latter her falling off.

TRY-Sail, a sail used by cutters, luggers, sloops, &c. in lieu of their main-sail during a storm. Try *Sail*, is also the name of a sail on board of a snow, which see.

TUB, is a kind of measure to denote the quantity of various things. A tub of tea, is about 60 pounds; a tub of camphor, from 56 to 80 pounds; and a tub of vermilion, from 300 to 400 cwt.

Tub, Match, the half of a cask, having notches sawn in its edge, wherein the lighted matches are placed during action, the bottom being covered with water to extinguish any sparks which may fall from the match.

*Topsail Halliard* Tubs, similar to half casks, in which the topsail halliards are coiled.

*Grog* Tub, a half cask set apart for mixing the daily allowance of spirits with water, prior to its being served out to the ship's company.

TUBE, in general, pipe, conduit, or canal; a cylinder, hollow withinside, either of lead, iron, wood, glass, or other matter, for the air, or some other fluid, to have a free passage or conveyance through.

Tube, in Astronomy, is sometimes used for a telescope, or, more properly, for that part into which the lenses are fitted, and by which they are directed and used.

TUBER, or Tubercle, a kind of round turgid root, in the form of a knob or turnip. The plants which produce such roots are hence denominated *tuberous*. Tuber is an old Latin name for any sort of excrescence, its derivation being from *tumeo*, to swell. It is applied to several things of the fungus tribe.

TUCK, that part of a ship where the ends of the bottom planks are collected together, immediately under the stem or counter.

*A Square* Tuck, is terminated above by the wing transom, and below and on each side by the fashion-pieces.

TUFAS, beds of lime deposited on vegetables, which by their destruction give great lightness and porousness to the mass.

TUISCO, a fabulous deity among the northern nations, from whom our Tuesday derives its name, that being the day on which his worship was more particularly celebrated.

TULIPA, Tulip, a genus of plants, of the class hexandria and order monogynia, and in the natural system ranging under the 10th order coronariæ.

TUMBLING Home, that part of a ship's side which falls inward above the extreme breadth, so as to make the ship gradually narrower from the lower deck upwards. In all old sea-books, this narrowing of a ship from the extreme breadth upwards is called housing-in.

TUMOUR, or Tumor, in Medicine and Surgery, a preternatural rising or hard swelling on any part of the body.

TUN, or Ton, originally signifies a large vessel or cask, of an oblong form, biggest in the middle, and diminishing towards its two ends, girt about with hoops, and used for stowing several kinds of merchandise, for convenience of carriage; as, brandy, oil, sugar, skins, hats, &c. This word is also used for certain vessels of extraordinary bigness, serving to keep wine for several years.

TUN, is also a certain measure for liquids, as wine, oil, &c.

TUN, is also a certain weight whereby the burdens of ships, &c. are estimated.

TUNE, or TONE, in Music, that property of sounds whereby they come under the relation of acute and grave to one another.

TUNGSTEN, a mineral found in Sweden, of an opaque white colour and great weight; whence its name tungsten or ponderous stone. This ore was analyzed by Scheele, who found that it was composed of lime and a peculiar earthy-like substance, which from his properties he called tungstic acid. The basis of the acid was found to contain a metal which was named tungsten, and which was obtained from the acid mixed with charcoal.

TUNICA, a kind of waistcoat or under garments, in use among the Romans.

TUNNEL, a large subterraneous arch driven through a hill for the passage of boats in a canal continued through the same.

TURBAN, the head dress of most of the eastern and Mahometan nations. In the adjustment of the turban much taste is displayed. In the folds, the dimensions, and colours of the turban, the rank and dignity of the wearer may frequently be known. The Emirs, who trace their descent from Mahomet, have green turbans, while the others are ordinarily red, with a white sash. Persons of distinction have frequent changes of turbans. The turban of the grand signor is as large as a bushel, adorned with three plumes of feathers, and enriched with diamonds and precious stones. It is so highly respected by the Turks, that they scarcely presume to touch it. That of the grand vizir has two plumes, superior in size to those of any inferior officer.

TURBOT, a well-known fish, uniformly held in high estimation.

TURDUS, the *Thrush*, in Natural History, a genus of birds of the order passeres.

TURF, the greensward, or surface of grass land.

TURMERIC, the *Indian Saffron*. It is now cultivated in England, and in the materia medica is officially known. It is also much used in yellow dyes.

TURN of the TIDE, the change from ebb to flood, or the contrary.

TURN *of a Rope*, the applying it once round any body, as a timber-head, &c. in order to hold on.

TURN *in the Hawse*. *See* HAWSE.

*To* TURN *in*, a sea phrase implying to go to bed, as

*To* TURN *Out*, is to get up or out of bed.

*To* TURN *in a Dead Eye or Heart*, to seize the end of a shroud or stay, &c. securely round it.

*To* TURN *over Men*, to discharge them out of one ship into another.

*To* TURN *the Hands up*, to call the ship's company upon deck for any particular purpose.

TURNAMENT, or TOURNAMENT, a martial sport or exercise which the ancient cavaliers used to perform, to shew their bravery and address.

TURNING. *See* LATHE.

TURNING TO WINDWARD, that operation in sailing, wherein a ship endeavours to make a progress against the direction of the wind, by a compound course inclined to the place of her destination; this is otherwise called plying or beating to windward. See the articles BEATING and TACKING.

TURNIP, a nutritious bulb-rooted plant, of which there are many sorts in cultivation by the gardeners and farmers.

TURNPIKE, a gate set up across a road, watched by an officer for the purpose, in order to stop travellers, waggons, coaches, &c. to take toll of them towards repairing or keeping the roads in repair.

TURPENTINE, a transparent sort of resinous juice, flowing either naturally or by incision from several unctuous trees, such as the larch, pine, fir, &c. Turpentine is too generally known to require a particular description, either of its nature or numerous uses.

TURRETS, among the Romans, were a kind of moveable towers, driven by men towards the place of attack, and containing soldiers, who were secure from the weapons of their assailants.

TUTENAG. This name is given in India to the metal zinc. It is sometimes applied to denote a white metallic compound, brought from China, called also Chinese copper, the art of making which is not known in Europe. Three ingredients of this compound may be discovered by analysis; namely, copper, zinc, and iron. Some of the Chinese white copper is said to be merely copper and arsenic.

TUTOR, one chosen to instruct children.

TUTTY, an argillaceous ore of zinc, found in Persia, formed on cylindrical moulds into tubulous pieces, like the bark of a tree, and baked to a moderate hardness.

TWICE-LAID CORDAGE, is made of cart rigging, which being untwisted, is again wrought up into ropes sufficiently strong for numerous purposes.

TWILIGHT, denotes that faint light which is reflected by means of the atmosphere before the sun rises, and after he sets.

TWINE, a kind of strong thread used in sail-making, and is of two kinds, extra for sewing the seams, and ordinary for the bolt-ropes.

TYCHONIC SYSTEM or HYPOTHESIS, an order or arrangement of the heavenly bodies, of an intermediate nature between the Copernican and Ptolemaic, or participating alike of them both. This system had its name and original from Tycho Brahe, a nobleman of Denmark, who lived in the latter part of the last century. This philosopher, though he approved of the Copernican system, yet could not reconcile himself to the motion of the earth; and being, on the other hand convinced the Ptolemaic scheme could not be true, he contrived one different from either. In this the earth has no motion allowed it but the annual. The Tychonic system then supposed the earth in the centre of the system, that is, of the firmament of stars, and also of the orbits of the sun and moon; but at the same time it made the sun the centre of the planetary motions, *viz.* of the orbits of Mercury, Venus, Mars, Jupiter, and Saturn. Thus, the sun, with all its planets, was made to revolve about the earth once a year, to solve the phenomena arising from the annual motion; and every twenty-four hours, to account for those of the diurnal motion.

TYE, a sort of runner or thick rope, used to transmit the effort of a tackle to any yard or gaff, which extends the upper part of a sail. The tye is either passed through a block fixed to the mast-head, and afterwards through another block attached to the yard or gaff, and returns to the mast-head, or the end of it is simply passed over a sheave in the mast-head, and then fastened to the said yard or gaff.

TYMPAN, among Printers, is a double frame, belonging to the press, covered with parchment, on which the blank sheets are laid in order to receive the impression.

TYMPANUM, or TYMPAN, in Mechanics, a kind of wheel placed round an axis or cylindrical beam, on the top of which are two levers or fixed staves, for the more easy turning the axis, in order to raise a weight required.

TYPE, among Printers, is a metallic composition cast into letters, and is a term of synonymous import. *See* PRINTING.

TYPE-METAL. The basis of type metal for printers is lead, and the principal article used in communicating hardness is antimony, to which copper and brass in various proportions are added. The properties of a good type metal are, that it should run freely into the mould, and possess hardness without being excessively brittle. The smaller letters are made of a harder composition than those of a larger size. It does not appear that our type founders are in possession of a good composition for this purpose. The principal defect of their composition appears to be that the metals do not uniformly unite. In a piece of casting performed at one of our principal founderies, the thickness of which was two inches, one side was hard and brittle when scraped, and the other side, consisting of nearly half the piece, was soft like lead. The transition from soft to hard was sudden, not gradual. If a parcel of letter of the same size and casting be examined, some of them are brittle and hard, and resist the knife, but others may be bent and cut into shavings. It may easily be imagined that the duration and neatness of these types must considerably vary.

TYPOGRAPHY. *See* PRINTING.

# U

U, or V, the twentieth letter of our alphabet. In numerals V stands for five; and with a dash added at top, thus V, it signifies five thousand. In abbreviations, amongst the Romans, V. A. stood for veterani assignati; V. B. viro bono; V. B. A. viri boni arbitratu; V. B. F. vir bonæ fidei; V. C. vir consularis; V. C. C. F. vale, conjux charissime, feliciter; V. D. D. voto dedicatur; V. G. verbi gratia; Vir. Ve. virgo vestalis; VL. videlicit; V. N. quinto nonarum.

U, as a contraction expresses *urbs* or *urbe*.

ULLAGE of a Cask, in Gauging, is what it wants of being full.

ULMUS, *the Elm*. Elms are forest trees well known in almost every part of England. There are several species, of which, however, only three, the common elm, wych hazel, or broad-leaved elm, and Dutch elm, grow in this country without cultivation. They are easily distinguishable, even by a common observer, from most other forest trees, by their leaves being rough, and doubly serrated at the edge.

ULTIMATE Ratios. To avoid both the tediousness of the ancients and the inaccuracy of the moderns, Sir Isaac Newton introduced what he called the method of prime and ultimate ratios, the foundation of which is contained in the first lemma of the first book of the Principia.

UMBELLIFEROUS Plants, are such as have their tops branched and spread out like an umbrella, on each little subdivision of which there is growing a small flower; such are fennel, dill, &c.

UMBER, or Grayling, (*Salmo Thymallus*,) is a fish of the salmon tribe, distinguished by having several longitudinal streaks upon its body, the first dorsal fin nearer the head than the ventral fins, the upper jaw longer than the lower one, the side nearly straight, and the tail forked. A fish of this species was caught lately in the Severn which weighed five pounds. The umber inhabits the clear and rapid streams of Europe and Siberia. These fish are so much esteemed in some parts of the continent, that they are exclusively reserved for the tables of the nobility. They are fattest in the autumn, but are best in season during the winter, particularly when the weather is cold; and they cannot be dressed too soon after they are caught. Many of the old medical writers strongly recommended umber as a wholesome fish for sick persons: they also stated that an oil prepared from its fat would obliterate freckles and other spots on the skin. By the Laplanders the intestines are frequently employed as a substitute for rennet, to coagulate the milk of the rein-deer when used for the making of cheese. These fish are in great esteem by anglers on account of their vivacity, the eagerness with which they rise at a bait, and their rapid motions through the water. They lurk close all the winter, and begin to be very active in April and May, about which time they deposit their spawn.

UMBRELLA, a well-known shade from the sun, or guard from the rain, formed by stretching silk, cotton, oil cloth, or other material, in a dome-like form over whalebone, and so constructed that it may be either spread or contracted, as circumstances may require. In Europe these conveniences have not been long in use. They were introduced from the East, where they have been known from time immemorial, but in a less elegant form than they have assumed since their importation among the western nations.

UNDECAGON, a polygon of eleven sides.

UNDULATORY Motion, is applied to denote a motion in any fluid, by which its parts are agitated like the waves of the sea, and is particularly applied to the motion of the air in the propagation of sound.

UNEVEN Number, or *Odd Number*, that which cannot be divided into two equal integral parts.

UNGULA, is the bottom part cut off by a plane passing obliquely through the base of a cone or cylinder, being thus called from its resemblance to the ungula or hoof of a horse, &c.

Ungula, among Surgeons, a sort of hooked instrument, used to extract a dead fœtus out of the womb.

UNICIA, the 12th part of a thing.

UNICIÆ, the same as co-efficient.

UNICORN. *See* Monoceros.

UNIT, or Unity, is the representation of any thing considered individually, without regard to the parts of which it is composed.

UNITARIANS, those Christians who believe in and worship one only self-existent God—the Father of Jesus Christ, in opposition to those who, besides the Father, worship his Son Jesus, and the Holy Ghost, and who are therefore called Trinitarians. The Unitarians are often called Socinians; but the Socinians were not Unitarians, because they paid divine worship to the Son of God.

UNITAS FRATRUM, or United Brethren, a name distinguishing those Christians who are frequently called Hernhuters abroad, and Moravians at home.

UNIVERSALISTS, those who hold that all future punishment is designed for correction, and that consequently all rational beings will be ultimately rendered happy by the God of love and mercy.

UNIVERSE, a collective term signifying the assemblage of heaven and earth, with all things in and upon them.

UNLACING, the act of loosening and taking off the bonnet of a sail from its principal part.

UNMOORING, reducing a ship to the state of riding by a single anchor and cable, after she has been moored and fastened by two or more cables. See the articles Anchor and Moor.

UNREEVING, the act of withdrawing or taking out a rope from any block, thimble, dead-eye, &c. through which it had formerly passed. See the article Reeve.

UNRIGGING, depriving a ship of her standing and running rigging.

UNSHIPPING, removing any piece of timber or wood from the place in which it was fitted, as, "unship the capstan bars," "unship your oars."

UNSLINGING, to take off slings, which see.

UPPER-DECK, the highest of those decks which are continued throughout the whole length of a ship.

Upper *Works*, a general name given to all that part of a ship which is above the surface of the water when she is properly balanced for a sea voyage.

UPRIGHT, the situation wherein the opposite sides of a ship are equally elevated above the surface of the water, or when she neither inclines to the right nor left, with regard to the vertical position of her stem and stern post.

URANIBURGH, the name given to the celebrated observatory of Tycho Brahe, founded by him in the little island of Weenen in the Sound.

URANIUM, a mineral found in Saxony, partly in a pure and partly in a mixed state. There are two varieties of these; the first of a blackish colour, quite opaque, and tolerably hard, and with a specific gravity of about 7·5. The second is distinguished by a finer black colour, with here and there a reddish cast; by a stronger lustre, not unlike that of pit coal; by an inferior hardness, and by a shade of green, which tinges its black colour when it is reduced to powder. Uranium is of a dark gray colour; internally it is somewhat inclined to brown.

URANUS, Herschel, or Georgium Sidus, the name of the new planet discovered by Dr. Herschel the 13th March, 1781. *See* Astronomy

URCHIN, The, or Hedge-Hog, is a small British quadruped, the upper parts of which are covered with spines, each about an inch long, and the under parts with hair. These animals are of considerable utility in several points of view. If kept, and allowed to run about rooms that are infested with leeches, cockroaches, or crickets, they will destroy the whole of them. Some persons imagine that they will devour mice, but this wants authentication. A hedge-hog, which was kept at the Angel Inn, at Felton, Northumberland, was tamed, and employed as a turnspit, and is said to have performed this duty in every respect as well as a dog of that name. The flesh of this animal is occasionally used as food, and is said to be very delicate eating. The skin, which was frequently employed by the ancients as a clothes' brush, is now used by farmers in some parts of the continent to put on the muzzles of calves which they are about to wean, that the cow may not permit them to suck. Several of the old writers have related accounts of very extraordinary, and at the same time very absurd, medical effects from different parts of this animal. Hedge-hogs frequent most commonly the bottoms of dry ditches, where they have shelter and concealment under bushes, fern, and grass. They sleep in the day-time, and are awake during the night, when they run abroad in search of worms, snails, insects, and other food. Few creatures can be more inoffensive. When attacked, they defend themselves by rolling into a globular form, and opposing on all sides a spinous surface. There is a notion, but it is apparently unfounded, that hedgehogs suck the milk of cows whilst lying in the fields asleep.

UREA, the constituent and characteristic matter of urine, may be obtained by the following process: evaporate by a gentle heat a quantity of human urine, voided six or eight hours after a meal, till it is reduced to the consistence of a thick syrup. In this state, when put by to cool, it concretes into a crystalline mass. Pour at different times upon this mass four times its weight of alcohol, and apply a gentle heat; a great part of the mass will be dissolved, and there will remain only a number of saline substances; pour the alcohol solution into a retort, and distil by the heat of a sand-bath till the liquid, after boiling some time, is reduced to the consistence of a thick syrup. The whole of the alcohol is now separated, and what remains in the retort crystallizes as it cools. These crystals consist of the substance known by the name of urea.

URIC ACID. Uric or lithic acid was discovered by Scheele in 1776. It is the most common constituent of urinary calculi, and exists also in human urine. It has a brown colour; is hard, and crystallizes into small scales. It has neither, taste nor smell, is insoluble in cold water, but soluble in 360 parts of boiling water.

URINE. The properties of urine vary considerably, according to the constitution and health of the body, and the period when it is voided after taking food. The urine of a healthy person is of a light orange colour, and uniformly transparent. It has a slightly aromatic odour, in some degree resembling that of violets. It has a slightly acrid saline bitter taste. The specific gravity varies from 1,005 to 1,033. The aromatic odour, which leaves it as it cools, is succeeded by what is called the urinous smell, which latter is converted to another, and finally to an alkaline odour. Urine converts the tincture of turnsol into a green colour, from which it is concluded that it contains an acid. No less than thirty different substances have been detected in urine by chemical analysis; *viz.* a great quantity of salts, acids, ammonia, &c.

Urine is much disposed to spontaneous decomposition. The time when this process commences, and the rapidity of the changes which take place, depend on the quantity of the gelatine and albumen. When the proportion of these substances is considerable, the decomposition is very rapid. This is owing to the great number of substances, and the united force of their attractions overcoming the existing affinities of the different compounds of which fresh urine consists, and especially to the facility with which urea is decomposed. This substance is converted during putrefaction into ammonia, carbonic acid, and acetic acid. Hence the smell of ammonia is always recognized while urine is undergoing these changes. Part of the gelatine is deposited in a flaky form, mixed with mucilage. Ammonia combines with phosphoric acid, and the phosphate of lime is precipitated. It combines also with phosphate of magnesia, and forms a triple salt. The other acids, the uric, benzoic, the acetic, and carbonic acids, are all saturated with ammonia.

URN, a kind of vase of a roundish form, but biggest in the middle, like our common pitchers. In ancient times they were much in use among most nations, to preserve the ashes of the dead, to contain liquids used at sacrifices, and to hold the lots upon which the destiny of events depended. At present they are known and valued only as ornaments, or vestiges of antiquity.

URSA MINOR, or CYNOSURA, the *Little Bear*, according to the poetry of the skies, represents Arcas, the son of Calista, who was placed by Jupiter in the heavens under the figure of a bear. This constellation embraces the pole of the world, and is easily distinguished by seven stars in the same form, but in a contrary position to those of the Wain, in the Great Bear.

*Boundaries and Contents.*—West and north by Draco, east by Camelopardalis, and south by Cassiopeia and Perseus. It extends from the North Pole to the Arctic Circle, and contains twenty-four stars, *viz.* one of the second magnitude, two of the third, four of the fourth, &c.

URSA MAJOR, the *Great Bear*, is said to be Calisto, an attendant of Diana, the goddess of hunting. Calisto was changed into a bear by Juno, and placed in the heavens by Jupiter. Another account, however, makes Ursa Major to be Arcas, the son of Jupiter and Calisto. Every one knows the story of Lycaon, king of Arcadia, being changed into a wolf, for killing his grandson Arcas, and setting him before Jupiter, to try the divinity of the father of gods and king of men. The ancients, it is said, represented the constellations of the Bears, each under the form of a waggon drawn by a team of horses. Ursa Major is well known to the country people at this day by the title of *Charles's Wain:* in some places it is called the Plough, an agricultural machine, which it certainly resembles.—*Boundaries and Contents.* North by Camelopardalis and Draco, east by Canes Venatici, south by Leo Minor, and west by Lynx and Camelopardalis.

URSUS, the *Bear*, in Natural History, a genus of mammalia, of the order feræ. There are ten species:—The brown bear, a native of Europe and Asia; the American bear, with a long pointed nose; the Polar bear, completely white and very much larger than the common or brown bear; the glutton, the wolverene, the racoon, and the common badger, found in almost all the temperate regions both of Europe and Asia, living in subterranean habitations, which its feet are admirably adapted for preparing. Its food consists of fruits and roots, frogs and insects; and the resemblance of its teeth to those of beasts of prey, makes it probable that it destroys lambs and larger animals, which it is stated to do: in a domestic state it prefers raw flesh to every other species of food. It will attack beehives, to obtain the honey contained in them. It sleeps much; passes the winter, or the greater part of it, in its burrowed residence, in a state of lethargy and torpor; and in summer produces generally three young ones at a birth. These animals are inoffensive in their manners; reluctant to attack, but well prepared by nature for defence, which they conduct with an alertness, intrepidity, and perseverance, truly admirable. To afford a spectacle of these qualities to the populace of several countries, the badger is often baited with dogs, which from the looseness of the badger's skin, and the coarseness of its hair, are prevented sometimes from penetrating to its flesh with their teeth, and, almost always, from so fastening him by their bite as to preclude his turning in various directions for their annoyance.

USE, is a trust and confidence reposed in another who is tenant of the land, that he shall dispose of the land according to the intention of him to whose use it is granted, and suffer him to take the profits.

USES AND CUSTOMS OF THE SEA, certain general principles, which compose the basis of marine jurisprudence, and regulate the affairs of commerce and navigation.

USURPATION, an injurious appropriation for any given time of the rights or property that justly belongs to another.

USURY, the exacting of a larger interest upon money than by law is allowed. The statute 12 Anne, c. 16, enacts, that no person upon any contract which shall be made, shall take for loan of any money, wares, &c. above the value of 5*l.* for the forbearance of 100*l.* for a year; and all bonds and assurances for the payment of any money to be lent upon usury, whereupon or whereby there shall be reserved or taken above five pounds in the hundred, shall be void; and every person who shall receive by means of any corrupt bargain, loan, exchange, shift, or interest, of any wares or other things, or by any deceitful way, for forbearing, or giving day of payment for one year, for their money or other things, above 5*l.* for 100*l.* for a year, shall forfeit treble the value of the moneys or other things lent.

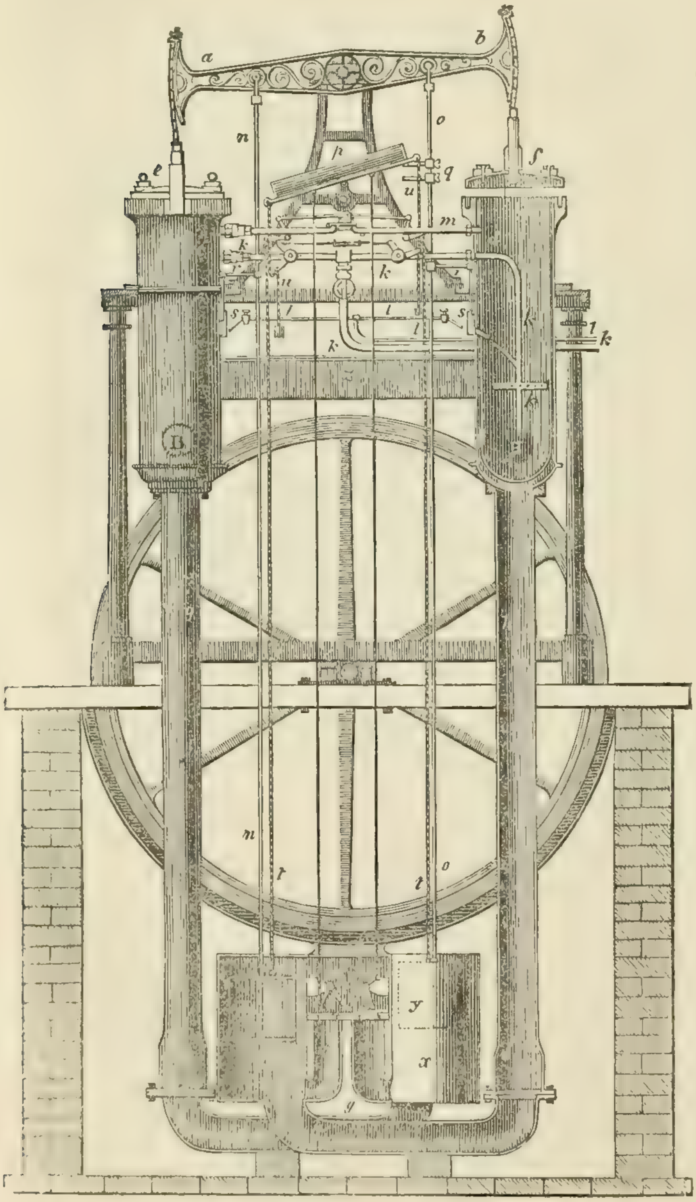
# V.

**VACATION**, in Law, is the whole time betwixt the end of one term and the beginning of another. This word is also applied to the time from the death of a bishop, or other spiritual person, till the bishopric or dignity is supplied with another.

**VACCINATION.** Cow-pock inoculation. Inoculation with the vaccine virus, for the purpose of securing against the infection of the small-pox.

**VACUUM**, in Philosophy, denotes a space empty or devoid of all matter or body.

**VACUUM ENGINE**, Brown's. Though this engine does not seem to have answered the expectations of its projectors, we very freely admit its description. Its principle is simply this: the formation of a vacuum in a cylinder by the combustion of hydrogen gas;—and that our readers may better comprehend the process by which this is done, and the power thereby obtained, we will first of all quote the inventor's own words.



" Inflammable gas is introduced along a pipe into an open cylinder or vessel, whilst a flame placed on the outside of, but near to the cylinder, is constantly kept burning, and at times comes in contact with and ignites the gas therein; the cylinder is then closed air-tight, and the flame is prevented from communicating with the gas in the cylinder. The gas continues to flow into the cylinder for a short space of time, then it is stopped off; during that time, it acts by its combustion upon the air within the cylinder, and at the same time a part of the rarefied air escapes through one or more valves, and thus a vacuum is effected. The vessel or cylinder is kept cool by water. Several mechanical means may be contrived to bring the above combination into use in effecting the vacuum with inflammable gas, and on the same principle it may be done in one, two, or more cylinders or vessels."—Having a vacuum effected by the above combination and some mechanical contrivance, powers are produced by its application to machinery in several ways. First, water wheels may be turned; secondly, water may be raised; and, thirdly, pistons may be worked.

*Description of the Engine as used for Turning a Water-wheel.*—The two cylinders *c* and *d* are the vessels in which the vacuum is to be effected; from these descend the pipes *g i g* and *h j h* leading into the lower cylinders *x*, *x*, from which the water rises along those pipes to fill the vacuum cylinders alternately. The water thus supplied is discharged through the pipes B into the tank or trough *z*, whence it falls upon the overshot water-wheel, and by the rotatory motion thus produced gives power to such machinery as may be connected to it. The water runs from the wheel along a case surrounding the lower half, into a reservoir, *v*, from which the lower cylinders *x x* are alternately supplied.

In order to produce the vacuum, the necessary quantity of gas is supplied to the cylinders by means of the pipe *k k k*, to be conveniently attached to a gasometer. The gas also passes along the small pipe *l l*, (communicating likewise with the gasometer,) and being lighted at both ends of that pipe, is constantly burning for the purpose of igniting the gas within the cylinders.

The water in the reservoir *v* passing down one of the pipes *w* into one of the lower cylinders *x*, causes the float *y* in that cylinder to rise, and pushing up the rod *o* raises the end *b* of the beam, which of course draws up with it the cap *f*, and forces down the cap *e* of the other cylinder *c*. The gas being admitted along the pipe *k*, the flame from the pipe *l* is now freely communicated to the gas in the cylinder through the orifice by the opening of the sliding valve *s*, which is raised by the arm *r* lifted by the rod *o* by means of the beam.

To produce the unremitting action of each cylinder, some subordinate machinery is put in operation by chains and rods attached to a glass or iron vessel *p*, partly filled with mercury, and, turning upon a pivot, each end receives its movements of elevation and depression from the rise and fall of the projecting arms *q* by the action of the beam above; the mercury being furnished for the purpose of regulating the supply of the gas into the cylinders, and the movement of the slide in the trough *v*. By the action thus communicated, the water from the reservoir flows down the pipe *w* into the vessel *x*, and produces the elevation of the float *y* and the rod *n*, and raises the cap *e* by the ascent of the beam at *a*. The motion thus caused in this part of the machinery, operating upon its duplicate parts on the other side, of course produces by its action a corresponding movement; and the slider in the trough *v*, moved by the action of the mercurial tube *p*, being removed from its position, allows the water to fall into the other pipe *w*, and as it ascends suffers the float *y* to descend, and rising into the main cylinder, thus lifts again the beam at *b* and its connexions, and forces down the cap *e* on the top of the other cylinder. After the vacuum is effected in the cylinders, the air must be admitted, to allow the water to be discharged and the caps to be raised; this is accomplished by means of a sliding valve in the air pipe *m m*, acted upon by chains *t t*, attached to the floats in the reservoir, and as motion is given to them, the valve is made to slide backwards and forwards, so as to allow of the free admission of atmospheric air.

Chains *u u* with suspended weights open the cocks in the pipe *k k*, and produce the alternate flow of the gas, and regulate and modify its supply. In the pipes *g i g* and *h j h* are clacks to prevent the return of the water when the air is admitted into the cylinders. When pistons are worked, the vacuum is effected (in the same manner as abovedescribed) under the piston, which is then pressed down by the weight of the atmosphere, and as an engine of that description is worked with two cylinders and pistons, the vacuum being produced in each cylinder alternately, the fall of one piston raises the other, and, being alternately pressed down, the piston rods give motion to the crank and fly-wheel. The air is admitted through large valves in the piston, and through orifices in the cylinders. An engine may be worked with one piston, the vacuum being produced in two cylinders, (as in the water engine,) from which a pipe communicates with a third cylinder in which the piston works, and into which the air is admitted alternately under and over the piston, while the vacuum extends to its opposite sides. By this contrivance a much greater rapidity of motion may be given to the piston, if required.

The method being therefore explained, in which, by the pressure of the air, the vacuum produced (and continued) is applied to useful purposes, Mr. Brown claims to be the inventor of the combination above described for effecting a vacuum, "*however much* it may be *varied* by the *mechanical means* with which it may be used, and also the inventor of applying a vacuum produced by the *combustion* of inflammable gas, to raising water, and to the production of motion in machinery by the pressure of the atmosphere."

The advantages to be derived from this engine, were detailed in the descriptive outline of the inventor, to be the following:—

1st. "The quantity of gas consumed being very small, the expense of working the engine is moderate. In its application on land, the saving will be extremely great, the cost of the coal gas (deducting the value of the coke) being inconsiderable. The expense of working a marine engine will certainly be greater, as the gas used for that purpose must be extracted from oil, pitch, tar, or some other substance equally portable, yet even in this case it will not equal the cost of the fuel required to propel a steam-boat; and, as a few butts of oil will be sufficient for a long voyage, vessels of the largest tonnage may be propelled to the most distant parts of the world.

2d. "The engine is light and portable in its construction, the average weight being less than *one-fifth* the weight of a *steam*-engine (*and boiler*) of the same power; it also occupies a much smaller space, and does not require the erection of so strong a building, nor of a lofty chimney. In vessels, the saving of tonnage will be highly advantageous, both in the smaller comparative weight and size of the engine, and in the very reduced space required for fuel.

3d. "This engine is entirely free from danger. *No boiler being used*, explosion cannot take place, and as the quantity of gas consumed is so small, and the only pressure that of the atmosphere, it is impossible that the cylinder can burst, or the accidents incidental to steam-boats occur."

The power of the engine being derived from the atmospheric pressure of ten pounds and upwards to the square inch) may be increased with the dimensions of the cylinders to any extent, and always ascertained by the index of the mercurial gauge; the power of the engine is best explained, by adverting to the fact of the mercury in the gauge being raised to the height of 24 inches and upwards. We saw it standing at 25 inches, though the inventor will not authorize any one to rate it higher than 22 inches, that being amply sufficient, as affording an available power superior to that of the condensing steam engine, there being no friction in an engine for raising water, and not more than one pound per square inch in a piston engine of any size. The number of strokes per minute which this engine made was twenty-nine, but a trifling alteration in the mechanism will increase the number to thirty-five or perhaps forty; in fact, the vacuum is so instantaneously formed, that any number of strokes which could be wished may be made. When pistons are worked in a separate cylinder, two or three strokes of the piston may be made with each stroke of the vacuum cylinder, *i. e.* each time the vacuum is effected.

**VAGABOND**, a person who wanders about, having no certain dwelling; such are sturdy beggars mentioned in divers statutes, on whom punishment may be inflicted.

**VAGRANTS**, are those who threaten to run away and leave their wives and children to the parish. All persons returning to a parish whence they have been legally removed, without a certificate from the parish to which they belong. All who, not having wherewith to maintain themselves, refuse to work. All who beg alms from door to door, or in the streets and highways. Likewise those who, not using proper means to get employment, or, possessing ability to work, refuse to do it; or spend money in ale-houses, or in any improper manner; and by not applying a proper proportion of their earnings towards the maintenance of their families, suffer them to become chargeable to the parish.

**VALVE**, in Hydraulics and Pneumatics, is a kind of lid or cover to a tube, vessel, or orifice, contrived to open one way, but which, the more forcibly it is pressed the other way, the closer it shuts the aperture, like the clapper of a bellows.

VALVE, in Anatomy, a thin membrane applied on several cavities and vessels of the body, to afford a passage to certain humours going one way, and prevent their reflux towards the place whence they came.

**VAN**, or VAUN, in Mining, is the washing on a shovel a small quantity of tin stuff, or ore, that has been pulverized, so that the waste being washed away, the quality of a large heap may be estimated from the pruduce of pure ore remaining in the van.

VAN, the foremost division of a naval armament, or that part which leads the way to battle, or advances first in the order of sailing. See the articles CENTRE, FLEET, REAR, &c.

**VANE**, a piece of bunting sewed upon a wooden frame called the stock, which turns upon a spindle at the mast head: its use is to shew the direction of the wind.

*Distinguishing* VANE, serves by its situation to denote what squadron a ship belongs to, and by its colour, or combination of colours, to point out the particular ship which bears it.

*Dog* VANE, a small light vane formed of thin slips of cork, stuck round with feathers, and strung upon a piece of twine. It is usually fastened to the top of a half-pike, and placed on the weather side of the quarter deck, in order to shew the helmsman the direction of the wind, particularly in a dark night, or when the wind is weak.

VANES, in Mathematical or Philosophical Instruments, are sights made to slide and move upon cross-staves, fore-staves, quadrants, &c.

**VANGS**, a sort of traces to steady the mizzen peek, extending from the peek downwards to the aftmost part of the ship's quarters, where they are hooked and drawn tight, so as to be slackened when the wind is fair, and drawn in to windward when it becomes unfavourable to the ship's course.

**VAPOUR**, a thin vesicle of water, or other humid matter filled or inflated with air, which being rarefied, ascends to a certain elevation in the atmosphere, and is there suspended till it returns in rain or snow. An assemblage of such vapours constitutes what is called a cloud.

VAPOUR *Bath*. *See* BATH.

**VARIATION**, is a term applied to the deviation of the magnetic needle, or compass, from the true north point, towards either east or west, called also Declination. The variation of the needle is properly defined the angle which a magnetic needle suspended at liberty makes with the meridian line on an horizontal plane; or an arch of the horizon, comprehended between the true and magnetical meridian. In the sea language it is usually called north-easting or north-westing. All magnetic bodies range themselves in some sort to the meridian; but it is rarely that they fall in precisely with it; in one place they decline from the north to the east, and from the south to the west; and in another place, on the contrary, from the north to the west, and from the south to the east, and that, too, differently at different times. Various are the hypotheses framed to account for this extraordinary phenomenon; we shall only mention some of the later and more probable; only premising, that Mr. Robert Norman, the inventor of the dipping needles, disputes against

Cortes's notion, that a variation was caused by a point in the heavens, contending that it should be sought for in the earth, and proposes how to discover its place. The first is that of Gilbert, which is followed by Cabeus, &c. This notion is, that it is the earth or land that draws the needle out of its meridian direction; and hence they agree that the needle varied more or less, as it was more or less distant from any great continent; consequently, that if it were placed in the middle of an ocean equally distant from equal tracts of land on each side, west and westward, it would not decline either to the one or the other, but point justly north and soth. Thus they say, in the Azores, which are equally distant from Africa on the east and America on the west, no variation is found; but as from the Azores you sail towards Africa, the needle begins to decline from the north to the east, and that still more till you reach the shore. If you still proceed eastward, the declination gradually diminishes again, by reason of the land left behind on the west, which continues to draw the needle. The same holds till you arrive at a place where there are equal tracts of land on each side, and there again there is no variation. The observations of our mariners in their East India voyages seem to confirm this system. As they proceed towards the Cape of Good Hope, the variation is still eastward; at length arriving at the Cape de los Aguillas, q. d. of the needles, the meridian line then dividing Africa into two equal parts, there is no variation at all, but as they proceed farther, and leave the African coast on the west, the variation becomes westward. But the misfortune is, the law does not hold universally; in effect, a great number of observations of the variations, in various parts, made and collected by Dr. Halley, overturn the whole theory. Others, therefore, have recourse to the frame and compasses of the earth, considered as interwoven with rocks and shelves, which being generally found to run towards the poles, the needle comes to have a general tendency that way, but which seldom going perfectly in the direction of the meridian, the needle, of consequence, has commonly a variation. Others hold various parts of the earth to have various degrees of the magnetic virtue, as some are more intermixed than others with heterogeneous matters, which prevent the free action or effect thereof. Others ascribe all to magnetic rocks and iron mines, which affording more of the magnetic than other parts, draw the needle more. Lastly, others imagine earthquakes or high tides to have disturbed and dislocated several considerable parts of the earth, and so changed the magnetic axis of the globe, which originally was the same with the axis of the globe itself.

Dr. Hooke communicated to the Royal Society, in 1674, a theory of the variation, the substance of which is, that the magnet has its peculiar pole, distant ten degrees from the pole of the earth, about which it moves, so as to make a revolution in 370 years; whence the variation, he adds, has altered of late about 10 or 12 minutes every year, and will probably so continue to do for some time, till it begins to become slower and slower, and will at length be stationary and retrograde, and in all probability may return.

Dr. Halley, in his day, gave another system, the result of a great number of observations, and even of a great number of voyages made at the public charge on this account. The light that excellent author imparted to this obscure portion of natural history is very great, and the consequences thereof in navigation, &c. are very considerable.

From these observations the learned author infers, 1. Throughout all Europe the variation at this time is west, and is more in the eastern parts thereof than in the western, increasing that way. 2. That on the coast of America the variation is westerly, increasing all the way as you go northerly along the coast, so as to be about 20° at Newfoundland, nearly 30° in Hudson's Straits, and not less than 57° in Baffin's Bay; and that as you sail eastward from this coast, the variation constantly diminishes. Hence he argues that somewhere between Europe and the north part of America there must be an easterly variation, or at least no variation. 3. That on the coast of Brazil there is an east variation increasing as you go to the southward, so as to be 12° at Cape Frio, and 20° and half over against Rio Plata, and thence sailing south-westerly to the Straits of Magellan, it decreases to 17, and at the west entrance is about 14°. 4. That eastward of Brazil this easterly variation decreases, so as to be very little at St. Helena and Ascension, and to be quite gone, and the compass point true about 11°, longitude west from the Cape of Good Hope. 5. That to the eastward of the aforesaid places, a westward variation begins, and governs in all the Indian Sea, rising to 18° under the equator, about the meridian of the northern part of Madagascar, and 27½° in 39° south latitude near the same meridian; easterly from thence the west variation decreases so as to be not much above 8 at Cape Comorin, and about 3° upon the coast of Java, and about the Molucca islands to be quite gone, as also a little to the westward of Van Diemen's Land. 6. That to the eastward of the Moluccas and Van Diemen's Land in south latitude, there arises another easterly variation, which seems not so great as the former, nor of so large extent; because, at the Isle of Rotterdam it is more sensibly felt than upon the east coast of New Guinea: and, at the rate it decreases, it may well be supposed that about 20° farther eastward, and 105 east longitude from London, in the latitude of 20° south, a westerly variation begins. 7. That the variation taken at Baldivia, and at the west entrance of the Straits of Magellan, shews that the east variation noted in the third observation is decreasing apace, and that it cannot extend many leagues from the South Sea into the coast of Peru and Chili, leaving room for a small westerly variation in that tract of the unknown world that lies in the midway between Chili and New Zealand, and between Hounds Island and Peru. 8. That in sailing north-west from St. Helena, by Ascension, as far as the equator, the variation continues very small east, as it were constantly the same; so that in this part of the world, the course, wherein there is no variation, is evidently no meridian, but rather north-west. 9. That the entrance of Hudson's Straits, and the mouth of Rio Plata, being nearly under the same meridian at the one place, the needle varies 29½° west; at the other 20½° east. This, he says, demonstrates the impossibility of reconciling these variations by the theory of Bond, which is by two magnetical poles, and an axis inclined to the axis of the earth: whence it would follow, that under the same meridian the variation should in all places be the same. From these circumstances the learned author takes occasion to assert, "that the whole globe of the earth is one great magnet, having four magnetical poles or points of attraction; near each pole of the equator two; and that in those parts of the world which lie nearly adjacent to any one of these magnetical poles, the needle is governed thereby, the nearest pole being always predominant over the more remote." The pole which at present is nearest to us, he conjectures to lie in or near the meridian of the Land's End of England, and not above 7° from the arctic pole; by this pole the variations in all Europe and Tartary, and the North Sea, are principally governed, though still with some regard to the other northern pole, whose situation is in the meridian, passing about the middle of California, and about 15° from the north pole of the world, to which the middle has chiefly respect in all North America, and in the two oceans on either side thereof, from the Azores westward, to Japan, and farther. The two southern poles, he imagines, are rather farther distant from the south pole of the world, the one about 16° therefrom in a meridian, 20° to the westward of Magellan's Straits, or 95° west from London; this commands the needle in all South America, in the Pacific ocean, and the greatest part of the Ethiopic ocean. The other seems to have the greatest power and the largest dominion of all, as it is the most remote from the pole of the world, being little less than 20° distant therefrom in the meridian which passes through New Holland and the island of Celebes, about 120° east from London; this pole is predominant in the south part of Africa, in Arabia and the Red sea, in Persia, India, and its islands, and all over the Indian Sea, from the Cape of Good Hope eastwards to the middle of the Great South Sea, that divides Asia from America. Such seems to be the present disposition of the magnetical virtue throughout the whole globe of the earth. It remains to shew how this hypothesis accounts for all the variations that have been observed of late, and how those variations answer to the several remarks which Dr. Halley made.

It is plain, as our European north pole is in the meridian of the Land's End of England, all places more easterly than that will have it on the west side of the meridian; and consequently the needle, respecting it with its northern point, will have a westerly variation, which will still be greater as you go to the eastward, till you come to some meridian of Russia, where it will be the greatest, and from thence will decrease again. Accordingly, in fact we find that at Brest the variation was but 1½°, at London 4½° (in 1683) and at Dantzic 7° west.

Again, to the westward of the meridian of Land's End, the needle ought to have an easterly variation, were it not that by approaching the American north pole (which lies on the west side of the meridian, and seems to be of greater force than this other) the needle is drawn thereby westward, so as to counterbalance the direction given by the European pole, and to make a small west variation in the meridian of the Land's End itself. Yet, about the Isle of Tercera, it is supposed our nearest pole may so far prevail as to give the needle a little turn to the east, though but for a very little space, the counterbalance of those two poles admitting no considerable variation in all the eastern ports of the Atlantic ocean, nor upon the west coasts of England and Ireland, France, Spain, and Barbary. But to the westward of the Azores, the power of the American pole overcoming that of the European, the needle has chiefly respect thereto, and turns still more and more towards it as we approach it. Whence it comes to pass, that on the coast of Virginia, New England, Newfoundland, and in Hudson's Straits, the variation is westward, that is, it decreases as you go from thence towards Europe, so that it is less in Virginia and New England than in Newfoundland and Hudson's Straits.

2. This westerly variation again decreases as you pass over North America, and about the meridian of the middle of California, the needle again points due north; and from thence westward to Yedzo and Japan, it is supposed the variation is easterly, and half sea over not less than 15°; and that this east variation extends over Japan, Yedzo, Tartary, and part of China, till it meets with the westerly, which is governed by the European north pole, and which is the greatest somewhere in Russia.

3. Towards the south pole the effect is much the same, only that here the south point of the needle is attracted. Whence it will follow, that the variation on the coast of Brazil, at the river of Plata, and so on to the Straits of Magellan, should be easterly, if we suppose a magnetical pole situate about 20° more westerly than the Straits of Magellan. And this easterly variation extends eastward over the greatest part of the Ethiopic sea, till it be counterpoised by the virtue of the other southern pole, as it is about midway between the Cape of Good Hope and the Isles of Tristan d'Alcunha.

4. From thence eastward, the Asiatic south pole becoming prevalent, and the south point of the needle being attracted thereby, there arises a west variation very great in quantity and extent, because of the great distance of this magnetical pole from the pole of the world. Hence it is, that in all the Indian seas, as far as New Holland, and farther, there is constantly a west variation, and that under the equator itself it rises to no less than 11° where it is most. And that about the meridian of the island of Celebes, being likewise that of this pole, this westerly variation ceases, and an easterly one begins, which reaches to the middle of the South Sea, between New Zealand and Chili, leaving room for a small west variation, governed by the American south pole.

5. From the whole it appears that the direction of the needle in the temperate and frigid zones depends chiefly upon the counterpoise of the forces of two magnetical poles of the same nature; as also why, under the same meridian, the variation should be in one place 29½° west, and in another 20½° east.

6. In the torrid zone, and particularly under the equinoctial, respect must be had to all the four poles, and their position must be well considered, otherwise it will not be easy to determine what the variation shall be, the nearest pole being always strongest; yet not so as not to be counterbalanced sometimes by the united forces of two more remote. Thus in sailing from St. Helena by the isle of Ascension to the equator, on the north-west course, the variation is very little easterly, and in that whole tract is unalterable; because the South American pole, which is considerably the nearest in the aforesaid places, requiring a great easterly variation, is counterpoised by the contrary attraction of the North American and the Asiatic south poles; each whereof singly is, in these parts, weaker than the American south pole, and upon the north-west course the distance from this latter is very little varied; and as you recede from the Asiatic south pole, the balance is still preserved by an access towards the North American pole. In this case, no notice is taken of the European north pole, its meridian being a little removed from those of these places, and of itself requiring the same variations. And after the same manner may the variations in other places, under and near the equator, be accounted for.

Variation *of the Variation*, is the change for the declination of the needle, observed at different times in the same place. This variation was first discovered by Mr. Henry Gellibrand, by comparing the observations made at different times near the same place by Mr. Burrough, Mr. Gunter, and himself, and the discovery was soon known abroad; for Kircher, in his treatise intitled "Magnes," says, that our countryman, Mr. John Creaves, had informed him of it; and then gives a letter of the famous Mersennus, containing a very distinct account of it. Indeed, in the History of the Royal Academy of Sciences at Paris, it is said by M. de Fontinetti, that the learned Gassendi himself acknowledged that he had before received information of Gellibrand's discoveries. This change is gradual and universal, and not accountable for. According to Dr. Halley, the variation of the variation of the compass is supposed to be owing to the difference of velocity of the motions of the internal and external parts of the globe. Such are the irregularities that experience has shewn us in the variation of the magnetic needle, which appear so considerable, that we cannot think it wholly under the direction of one general and uniform law: but rather conclude, with the learned and judicious Dr. G. Knight, that it is influenced by various and different magnetic attractions, in all probability occasioned by heterogeneous compositions in the great magnet, the earth.

VARNISHING. Varnish is a clear limpid fluid, which hardens without losing its transparency. It is used by painters, gilders, &c. to give a lustre to their works, and to preserve and defend them from the air and moisture. A coat of varnish ought to possess the following properties:

1. It must exclude the action of the air; because wood and metals are varnished to defend them from decay and rust. 2. It must resist water; else the effect of the varnish could not be permanent. 3. It ought not to alter the colours it is intended to preserve. It is necessary, therefore, that every varnish should be easily spread over the surface, without leaving pores or cavities, that it should not crack or scale, and that it should resist water.

Resins are the only bodies that possess these properties; they must therefore form the basis of every varnish. For this purpose they must be dissolved as minutely divided as possible, and combined so that the imperfections of those that might be disposed to scale may be corrected by others. Resins may be dissolved by three agents: 1. by fixed or fat oil; 2. by volatile or essential oil; 3. by spirit of wine. Accordingly we have three kinds of varnish; *fat* or *oily varnish, essential varnish*, and *spirit varnish*. And these agents are of such a nature as either to dry up and become hard, or else to evaporate and fly off, leaving the resin fixed behind.

Varnishes should be carefully kept from dust, and in very clean vessels: they should be laid thin and even with a large flat brush, the strokes being drawn all one way. A warm room does best for varnishing in, cold chills the varnish and prevents it from lying even.

Varnishes are polished with pumice-stone and tripoli. The pumice-stone reduced to a fine powder is put upon a piece of serge moistened with water; and with this the varnished substance is rubbed equally and lightly. The tripoli, also reduced to a fine powder, is put upon a clean woollen cloth moistened with olive oil, with which the polishing is performed. The varnish is then wiped with soft linen, and when dry, cleaned with starch, or Spanish white, and rubbed with the palm of the hand, or a linen cloth.

*Fat Oil Varnish.*—Fixed or fat oil does not evaporate, nor become dry of itself. And therefore to make it dry it is boiled with metallic oxydes. Litharge is generally used for this purpose. Oil so prepared is called *drying-oil.* But to accelerate the drying of oil-varnish, we add oil of turpentine.

Gum-copal and amber are the substances chiefly employed in oil varnishes; the copal is white, and used for varnishing light, the amber for dark colours. Before mixing them with the oil, it is best to dissolve them; because they are then in less danger of being scorched, the varnish is also more beautiful. They should be melted in an iron pot; they are in a proper state for receiving the oil when they offer no resistance to the iron spatula, and run off from it drop by drop.

To make oil varnish, pour, by little and little, six or eight ounces of drying oil among sixteen ounces of melted copal or amber, constantly stirring the ingredients with the spatula. When the oil is well mixed with the copal or amber, take it off the fire; and when nearly cool, put in sixteen ounces of the essence of Venice turpentine. The varnish should be passed through a linen cloth. Oil varnishes become thick by keeping; when they are to be used, it is only necessary to pour in a little Venice turpentine, and put them a short time on the fire. Less turpentine is necessary in summer than winter; too much oil hinders the varnish from drying; when too little is used, it cracks and does not spread properly.

*To make the best White Hard Varnish.*—Rectified spirits of wine, 2 galls.; gum ancine, 4 oz.; gum mastich, 1 lb.; gum sandarach, 5 lbs. Put these into a clean can or bottle to dissolve, in a warm place, frequently shaking it; when the gum is dissolved, strain it through a lawn sieve, and it is then fit to use.

*Black Varnish for Coaches and Iron Work.*—This varnish is composed of asphaltum, resin, and amber, melted separately, and afterwards mixed, the oil is then added, and afterwards the turpentine, as directed above. The proportions are, twelve ounces of amber, two of resin, two of asphaltum, six of oil, and twelve of turpentine.

*A Varnish for rendering Silk Impenetrable to Water and Air.*—To render linseed-oil drying, boil it with two ounces of sugar of lead, and three ounces of litharge, for every pint of oil, till the oil has dissolved them; then put a pound of bird-lime, and half a pint of the drying oil, into an iron or copper pot holding about a gallon, and let it boil gently over a slow charcoal fire, till the birdlime ceases to crackle; then pour upon it two pints and a half of drying oil, and boil it for about an hour longer, stirring it often with an iron or wooden spatula. As in boiling the varnish swells much, the pot should be removed from the fire, and replaced when the varnish subsides. While it is boiling it should be occasionally examined, to determine whether it has boiled enough. For this purpose take some of it upon the blade of a large knife, and after rubbing the blade of another knife upon it, separate the knives; and when on their separation the varnish forms threads between the two knives, it has boiled enough, and should be removed from the fire. When it is almost cold, add about an equal quantity of spirits of turpentine; mix both well together, and let the mass rest till the next day; then having warmed it a little, strain and bottle it. If it is too thick, add spirits of turpentine. This varnish should be laid upon the stuff when perfectly dry, in a lukewarm state; a thin coat of it upon one side, and about twelve hours after two other coats should be laid on, one on each side; and in twenty-four hours the silk may be used.

*Blanchard's Air Balloon Varnish.*—Dissolve elastic gum (Indian-rubber,) cut small, in five times its weight of spirits of turpentine, by keeping them some days together; then boil one ounce of this solution in eight ounces of drying linseed-oil for a few minutes, and strain it: use it warm.

*Essential Oil Varnish.*—The essential varnishes consist of a solution of resin in oil of turpentine. This varnish being applied, the turpentine evaporates, leaving the resin behind. They are commonly used for pictures.

*To dissolve Gum Copal in Oil of Turpentine.*—The quantity to be dissolved should be put into a glass vessel capable of containing at least four times that quantity, and it should be high in proportion to its breadth. Reduce two ounces of copal to small pieces, put them into a proper vessel. Mix a pint of oil of turpentine with one-eighth its quantity of spirit of sal ammoniac; shake them well together; put them to the copal, cork the glass, and tie it over with a string of wire, making a small hole through the cork. Set the glass in a sand heat so regulated as to make the contents boil as quickly as possible, but so gently, that the air-bubbles may be counted as they rise from the bottom. The same heat must be kept up till the solution is complete. It requires accurate attention to succeed in this operation. After the spirits are mixed they should be put to the copal, and the necessary degree of heat given as soon as possible. It should likewise be kept up with the utmost regularity. If the heat abates, or the spirits boil quicker than is necessary, the solution will immediately stop, and with the same materials will afterwards be in vain to proceed: but if properly managed, the sal ammoniac spirit will gradually descend from the mixture, and attack the copal, which will swell and dissolve, except a very small quantity that will remain undissolved. The vessel should not be opened till some time after it has cooled, as it has happened that on uncorking the vessel when it was not warm enough to affect the hand, that the contents have been blown against the ceiling. The spirit of turpentine should be of the best quality, had from Apothecaries' Hall. This varnish, though a rich deep colour in the bottle, gives no colour to the pictures it is laid on. If left in the damp it remains tacky a long time; but in a warm room, or the sun, it dries as other turpentine varnishes.

*Spirit Varnishes.*—When resins are dissolved in alcohol,(spirits of wine,) the varnish dries speedily, but cracks. This fault is corrected by adding a small quantity of oil of turpentine, which renders it brighter and less brittle when dry.

*To dissolve Gum Copal in Spirits of Wine.*—Dissolve half an ounce of camphor in a pint of alcohol, put it into a circulating glass, add four ounces of copal in small pieces; set it in a sand heat, so regulated that the air-bubbles may be counted as they rise from the bottom; and continue the same heat till the solution is completed. Camphor acts more powerfully upon copal than any other substance. If copal finely powdered be rubbed with a small quantity of dry camphor in the mortar, the whole becomes in a few minutes a tough coherent mass. The most economical method is to set the vessel which contains the solution by for a few days; and when perfectly settled, pour off the clear varnish, and leave the residuum for a future operation. This is a very bright solution of copal, and an excellent varnish for pictures, besides being an improvement in fine japan works, as the stoves used in drying those articles may drive off the camphor entirely, and leave the copal pure and colourless upon the work. Copal dissolves in spirits of turpentine, by the addition of camphor, with the same facility, but not in the same quantity, as in alkohol.

*A Varnish for Wainscot, Cane Chairs, &c.*—Dissolve in a quart of spirits of wine, eight ounces of gum-sandarach, two ounces of seed-lac, and four ounces of resin; then add six ounces of Venice-turpentine. If the varnish is to produce a red colour, more of the lac and less of the sandarach should be used, and a little dragon's blood should be added. This varnish is very strong.

*A Varnish for Toilet Boxes, Cases, Fans, &c.*—Dissolve two ounces of gum-mastich, and eight ounces of gum sandarach, in a quart of alcohol; then add four ounces of Venice turpentine.

*A Varnish for Violins, and other Musical Instruments.*—Put four ounces of gum sandarach, two ounces of lac, one ounce of gum-elemi, into a quart of alcohol, and hang them over a slow fire till they are dissolved; then add two ounces of turpentine.

*Varnish for employing Vermilion for Painting Equipages.*—In a quart of alcohol dissolve six ounces of gum sandarach, three ounces of gum lac, and four ounces of resin; add six ounces of the cheapest kind of turpentine afterwards: mix it with a proper quantity of vermilion when used.

*Seed Lac Varnish.*—Put one quart of spirits of wine in a wide-mouthed bottle, add eight ounces of seed-lac, clear and free from dirt; let it stand two days or longer in a warm place, shaking it often. Strain it through a flannel into another bottle, and it will be fit for use.

*Shell-Lac Varnish.*—Take one quart of spirits of wine, eight ounces of thin transparent shell lac, which if melted in the flame of a candle, will draw out in fine long hair; mix and shake these together, and let them stand in a warm place for two days, and it will be ready for use. This varnish is softer than that made from seed-lac, and not so useful, but may be mixed with it for varnishing wood, &c.

*White Varnish for Clock Faces, &c.*—Take of highly rectified spirits of wine one pint, which divide into four parts; then mix one part with half an ounce of gum-mastich in a phial, one part of spirits, and half an ounce of gum-sandarach in another phial, one part of spirits, and half an ounce of the whitest parts of gum-benjamin. Then mix and temper them to your mind, and it may not be amiss to add a little bit of white resin, ochre, Venice turpentine, in the mastich bottle, to give a gloss. If your varnish be strong and thick, add spirits of wine only; if hard, some dissolved mastich; if soft, some sandarach of benjamin. When you have brought it to a proper temper, warm the silvered plate before the fire (if a clock face, taking care not to melt the wax,) and with a flat camel's hair pencil stroke it all over until no white streaks appear, and this will preserve silvering many years.

VASE. *See* URN.

VAULT, in Architecture, an ached roof, so contrived that the stones which form it sustain each other. Vaults are, on many occasions, to be preferred to soffits or ceilings, as they give a greater height and elevation, and are besides more firm and durable.

**VAULTING**, in the article GYMNASTICS, page 430, we referred to the word *Vaulting* for this branch of those physical exercises.—By means of a very simple instrument a great number of our most useful exercises in vaulting may be executed. The figures 6 and 7 of the plate Gymnastic Exercises can be employed to perform all the exploits of the pole. The vaulting beam *i k*, fixed between the two standards *c d*, renders it fit for performing on it all the elementary exercises of vaulting. A board with the edges rounded, placed in the same direction, between the standards, may serve to accustom young people to walk on narrow objects, fixed at several elevations. The same board, as in *e f*, fig. 7. fixed like the pole, can be employed with advantage to accustom them to raise the body as high as possible, supported only by the last phalanges of the fingers. A rope with a small sack filled with sand at each end, two little iron spikes to support and make it easily moveable upwards and downwards, presents the most useful and least dangerous instrument to exercise boys in every kind of jumping.—Those who have but a small room, in order to exercise the arms, may fix in one of the corners, at six or eight feet from the ground, and from one wall to the other, a strong pole, eight feet long and three inches thick, on which the following exercises can be performed, which are the most useful in increasing prodigiously the strength of the upper limbs.

*Hanging by both Arms*, Figure 7, No. 1 and 4.—Here the two arms ought to support for several minutes the whole weight of the body, by which they will be stretched while all the other parts of the body hang loose. This cannot be done by children of a weak constitution, for it is necessary that they should raise their knees, and for safety, some one should remain near them to prevent their falling. In descending, let both hands go at once, and light on both points of the feet, the knees bent as a bird alights, and the upper part of the body inclined forwards.

*Hanging alternately on one Hand and Foot*, No. 3.

*Hanging on both Hands, the Nails turned inside*, No. 1 and 4.

*Hanging on both Arms outside, like* No. 5.—In this position communicate to the body a swinging movement backwards and forwards; and after balancing a moment jump backwards, let go both hands at once, and come down on the points of the feet.

*Sliding Sideways.*—This consists in bringing the body from one end of the pole to the other, by moving upon it one hand after another in an oblique direction. Children of a weak constitution ought, during this action, to be a little sustained in the loins; and it is necessary to oblige them, during the exercise, to raise their knees as high as possible, and to move them in concert with the arms.

*Hand over Hand.*—Fixed on the pole, as is represented in No. 4, move forwards and backwards, passing one hand over the other, carefully observing in the beginning to fix the hands not too far from one another.

*Advancing by Jumps,*—Or moving both hands at once from one place to another; at first forwards from one end of the pole to the other, and after that the same exercise in a contrary direction.

*Hanging on the Elbows backwards, and Balancing.*—In this movement it is necessary in jumping down, to let go both arms at once, in the very moment the feet are moving backwards.

*Changing both Hands at once.*—Is to take several times alternately the position as figs. 1 and 4, without coming on the ground.

*Right about Face,*—Is one of the most difficult of these exercises; it ought therefore to be made very gently. Fixed as in No. 4, after having raised the body as high as possible, let go both hands at once, bring them on the pole in an opposite direction, as you were before. By this movement the body has made right about face.

*To turn over*, No. 6.—The hands fixed as before; after a strong movement of impulse, bring your legs upwards and lie upon the pole with the girdle, or if you can well support yourself without loosening your hands, turn round the pole and come on your feet.

This is the genuine *Salto mortale*, fixed by the hands or feet over-head. The same exercise can be done having the hands fixed as in number 5 and 6.

*To Slide down.*—Sitting in the middle of the pole, both hands fixed on one side of the body, to the right for example. The right hand near the right hip, the nail turned to the face, the hands strongly fixed. From this position slide gently forward, and you will hang on both arms; after having turned over, come up again, sit upon the poles as before, and repeat the exercise several times on both sides without coming on the ground.

*Leaping.*—In general, of all the leaps, the most sure, useful, and agreeable, is the vaulting in a straight direction, and is that which we can employ on a great many occasions. A man who has acquired the facility to perform it well, may easily jump over objects of his own height, and even more, without any danger whatever.

The first exercises which we ought to make in order to supple all the joints, are in general, the most useful and profitable for every kind of jump.

In raising the knees and supporting the body in equilibrium upon the hands, bring the legs several times up and down without touching the beam with any other part of the body. After having practised this exercise a little time, it will be very easy for any body to stand on the beam, since, to rise up from the first position, there is nothing else to be done than to bend the body a little forwards, bring the heel of the right foot before the ancle of the left, and rise up gently. To come down, the knees bent gradually, the hands come on the beam, and as soon as the weight of the body lies upon them, the feet leave their place, and take their first position.

*In Walking forwards,*—From the first position, bring one hand forwards by sliding it close to the other, till the last articulation of the thumb of the moving hand comes in the direction of the nail of the other, and then continue on the same way till you can perform it with ease, always observing an equal distance in your steps.

*In Walking backwards.*—The same exercise, moving backwards, though much more difficult than the preceding, may be executed very soon by those who have well observed the rules of the former. Here, while the hands are moving backward, the upper part of the body is kept forward.

*Jumping between.*—To perform this exercise easily, place the beam the height of the middle of the thigh; put both hands upon it, and by giving a little impulse upwards, brings both feet at once, close between the hands, without moving them from their place, and continue the same exercise until it can be done easily. Having acquired some dexterity in this, try, by jumping in the same manner, to pass one leg through the hands, and return without touching the beam with it. In passing the leg through, the body is kept backward, and in bringing it back, it is bent forward. Do the same with both legs together, observing the same rules.

*Jumping through.*—Here it is necessary to have some one to stand by to assist; and in the beginning this exercise ought to be made with very great precision. The preceding exercises having been well made, it will be very easy to jump through the hands, because there is nothing else to be observed than to push the body forwards and let both hands go at once after the legs are passed through the hands in a straight direction.

*Jumping over.*—This manner of jumping is very agreeable and sure, because in the action we have always the power to direct the body with the greatest ease in whatever direction we please. Placed before the beam, which is at first as high as the hips, lay both hands upon it, then bending down raise the body at once with all your strength over the beam. In jumping to the right, the left foot passes between both hands, the right hand lets go, and the left guides the body in its fall. In jumping to the left, the right foot passes between both hands.

In whatever direction this jump be made, you ought not only to be master of your equilibrium, but must also be able to point out, before jumping, the place where you intend to fall, observing at the same time to come on the ground on both feet, the knees projected forward, the hands ready to neutralize the fall if necessary.

*Parallel Bars.*—The instruments employed to perform the exercises here described, are two pieces of wood from six to eight feet in length, and four inches square, the edges rounded. For grown men they are fixed at two feet distance from one another, and for children, at eighteen inches, supported by two round standards firmly fixed in the ground, and from three to four feet high, according to the stature of the boys.

It is necessary that during the exercises the instructor should always remain near the boy who is exercising, on purpose to assist him if he should make a false movement.

*Balancing,* No. 1.—Being placed in the middle of the bars, and between both, put your hands right and left on each bar on the same line. After a little jump upwards, preserve your equilibrium on both wrists, the legs close, and in that position which we call the first: then communicate to your body a gentle movement of balancing from behind, forwards, and continue so several times. In the beginning, it is necessary to observe, not to bring the feet too high to make this exercise with precision, and without making any movement with the arms; the body moving as it were upon a pivot.

*To bring both legs over.*—From the first position, after a little movement of balancing, bring both legs close and at once, over one of the bars forwards without touching it, or moving your hands from their place. The same ought to be made backwards right and left.

*Crossing.*—After having made several times the preceding exercises, and got some readiness in them, you can try this: having both legs on the right (where the right hand lies) bring them in at once upon the left backwards, after that between, then over the left forwards, from thence over the right backwards, and continue on in the same manner from right backwards to the left forwards, between, over the right forwards, and over the left backwards.

*Doubling.*—Having both legs over the left bar, forwards, bring them close, and without falling between, or touching the bars, place them over the right forwards, then over the left, and continue so for some time. The same exercise, behind, is much more difficult, but by practice you may acquire readiness in this as well as in the former. Observe to bring the body forwards at the same time that you bring your legs over both bars.

*To Jump out.*—After having communicated to the body a movement of balance, the moment in which the legs are raised over the bars, jump backwards over the right, without touching it with the feet or waist; then perform the same jump forwards. By the vaulting jump you may easily come between the bars, and also bring your body over both, without touching them otherwise than with your hands.'

*To rise up, fixed by the legs.*—Sitting upon one of the bars, place the upper part of your feet under the lower part of the other bar, and slide backwards upon your thighs till you come to hang in the joints of your knees. In this position the points of your feet, and the upper part of your calves, are the only part of the body which touch the bars. Also fixed, bring the upper part of your body gently down and backwards, laying your hands crossed upon the chest, and holding the head upright, then raise up your trunk several times. At the beginning make this exercise no more than five or six times without rest. When once accustomed to it, you may perform it forty or fifty times without any ill consequence attending it.

*Moving upon the Hands forwards and backwards.*—To perform this exercise either forwards or backwards, it is necessary to make but little movement in sliding your hands upon the bar, holding the body upright. No. 1.

*Advancing by Leaps.*—From the first position, after having communicated to the body an impulsion forwards, lift both hands at once, and bring them forwards upon the bars, keeping them always in the same line. To execute this exercise backwards, it is necessary to keep the upper part of the body as much forwards as possible.

*To rise, and sink down,* No. 2.—In equilibrium in the middle of the bars, place the legs backwards, the heels close to the upper part of the thigh. From this position come gently down till the elbows rest upon the bars; then rise up gently without any impulse, or touching the ground with your feet. This ought to be repeated several times without resting. As soon as you can perform this easily, in rising up try to bring the knees as high as possible in the direction of the face.

*To touch the ground with the knees.*—In this exercise the legs are folded backwards, and the same movements are made as in the former, by going gently down between the bars, till the knees touch the ground, moving up and down several times.

VECTOR, in Astronomy, a line supposed to be drawn from any planet moving round a centre, or the focus of an ellipsis, to that centre or focus.

To VEER AND HAUL, to pull a rope tight by drawing it in and slackening it alternately till the body to which it is applied acquires an additional motion like the increased vibrations of a pendulum, so that the rope is strained to a greater tension with more facility and despatch; this method is particularly used in hauling the bowlines. The wind is said to veer and haul when it alters its direction, and becomes more or less fair. Thus it is said to veer aft, and haul forward.

VEERING is the operation by which a ship, in changing her course from one board to the other, turns her stern to windward. See the article WARE.

VEIN, among Miners, is that space which is bounded with woughs, and contains ore, spar, canck, clay, chirl, croil, browheu, pitcher-chirt, cur, which the philosophers call the mother of metals, and sometimes soil of all colours. When it bears ore, it is called a quick vein; when no ore, a dead vein.

VELVET, a rich kind of stuff, all silk, covered on the outside with a close, short, fine, soft shag, the other side being a very strong close tissue.

VENEERING, VANEERING, or *Fineering,* a kind of marquetry or inlaying, whereby several thin slices or leaves of fine woods, of different kinds, are applied and fastened on a ground of some common wood. There are two kinds of inlaying, the one which is the most common and more ordinary, goes no farther than the making of compartments of different woods; the other requires much more art, in representing flowers, birds, and similar figures. The first kind is properly called veneering, the latter is more properly called marquetry. The wood used in veneering is first sawed out into slices or leaves about a line in thickness; *i.e.* the twelfth part of an inch. In order to saw them, the blocks or planks are placed upright, in a kind of sawing press. These slices are afterwards cut into narrow slips, and fashioned divers ways, according to the design proposed; then the joints having been exactly and nicely adjusted, and the pieces brought down to their proper thickness with several planes for the purpose, they are glued down on a ground or block with good strong English glue. The pieces being thus jointed and glued, the work, if small, is put in a press; if large, it is laid on a bench, covered with a board, and pressed down with poles or pieces of wood, one end of which reaches to the ceiling of the room, and the other bears on the board. When the glue is thoroughly dry, it is taken out of the press and finished, first with little planes, then with scrapers, some of which resemble rasps, which take off the dents, &c. left by the planes. After it has been sufficiently scraped, they polish it with the skin of a dog-fish, wax, and a brush, or polisher of shave-grass; which is the last operation.

VENOM. *See* POISON.

VENTILATION, comprises the various modes by which impure air is removed or renovated by introducing a current of pure atmospheric air.

VENTILATOR, a machine by which the noxious air of any close place, as a hospital, gaol, ship, chamber, &c. may be changed for fresh air.

VENTRILOQUISM, an art by which certain persons can so modify their voice as to make it appear to the audience to proceed from any distance, and in any direction. It appears that ventriloquism is the art of mimicry, an imitation applied to sounds of every description, and attended with circumstances which produce an entertaining deception, and lead the hearers to imagine that the voice proceeds from different situations. When distant, and consequently lower voices are to be imitated, the articulation may be given with sufficient distinctness, without moving the lips, or altering the countenance. It was by a supposed supernatural voice of this kind, from a ventriloquist, that the famous musical small-coal man, Thomas Britton, received a warning of his death, which so greatly affected him that he did not survive the affright.

**VENUE**, the neighbourhood from whence juries are to be summoned for trial of causes. In local actions, as of trespass and ejectment, the venue is to be from the neighbourhood of the place where the lands in question lie; and in all real actions the venue must be laid in the county where the property is for which the action is brought.

**VENUS**, in Astronomy, one of the inferior planets, revolving round the sun in an orbit between that of Mercury and the Earth.

**VEPRECULÆ**, diminutive from vepres, "a briar or bramble," the name of the thirty-first order in Linnæus's Fragments of a Natural Method.

**VERB**, in Grammar, a word serving to express what we affirm of any subject, or attribute to it.

**VERDICT**, the answer of a jury made upon any cause, civil or criminal, committed by the court to their examination; and this is two-fold, general or special. A general verdict is that which is given or brought into the court in like general terms to the general issue; as, guilty or not guilty generally. A special verdict is, when they say at large that such a thing they find to be done by the defendant or tenant so declaring the course of the fact, as in their opinion it is proved; and as to the law upon the fact, they pray the judgment of the court; and this special verdict, if it contain any ample declaration of the cause from the beginning to the end, is also called a verdict at large. A special verdict is usually found where there is any difficulty or doubt respecting the laws, when the jury state the facts as proved, and pray the advice of the court thereon. A less expensive and more speedy mode, however, is, to find a verdict generally for the plaintiff, subject, nevertheless, to the opinion of the judge, or the court above, or a special case drawn up and settled by counsel on both sides.

**VERDIGRIS**, is an acetate of copper, useful in the arts as a pigment.

**VERGERS**, certain officers of the courts of King's Bench and Common Pleas, whose business it is to carry white wands before the judges. There are also vergers of cathedrals, who carry a rod, tipped with silver, before the bishop, dean, &c.

**VERJUICE**, a liquor obtained from grapes or apples unfit for wine or cider; or from sweet ones whilst yet acid and unripe.

**VERMES**, in Natural History, the last class of the animal kingdom, according to the Linnæan system. The animals in this class are not merely those commonly known by the name of worms, but likewise those which have the general character of being "slow in motion, of a soft substance, extremely tenacious of life, capable of reproducing such parts of their body as may have been taken away or destroyed, and inhabiting moist places." There are five orders in this class, *viz.* the infusoria, intestina, mollusca, testacea, zoophyta.

**VERMICELLI**, a composition of flour, cheese, yolks of eggs, sugar, and saffron, reduced to a paste, and formed into long slender pieces like worms, by forcing it with a piston through a number of little holes.

**VERMIN**, a collective term which includes the various sorts of small animals that are injurious to the corn, fruit, and other produce of the farmer.

**VERNIER**, a scale adapted for the gradation of mathematical instruments.

**VERSE**. *See* Poetry.

**VERSED** Sine of an Arch, a segment of the diameter of a circle, lying between the foot of a right sine and the lower extremity of the arch.

**VERTICAL** Circle, in Astronomy, a great circle of the sphere passing through the zenith and nadir, and cutting the horizon at right angles: it is otherwise called azimuth.

Vertical *Plane*, in Perspective, is a plane perpendicular to the geometrical plane, passing through the eye, and cutting the perspective plane at right angles.

**VESPERTILIO**, the *Bat*, in Natural History, a genus of mammalia, of the order primates. Generic character: teeth erect, sharp-pointed, approximated; fore-feet palmated, with a membrane surrounding the body, and by which the animal is enabled to fly. Bats fly only by night, in quest of their food, consisting of gnats and moths, and when deprived of their eyes appear to feel no want of them, having a supplementary power of perception, by which they avoid objects in the way with nearly as much precision as in their perfect state. In cold climates they pass the winter in torpor, assembling in holes and in caverns, in which they are occasionally seen adhering in great numbers to the walls, and sometimes suspended by their hind legs. The bones of the extremities of the fore-legs of bats are continued into long and thin processes, connected by a fine and almost transparent skin, which they are enabled to unfold optionally for flight, or to withdraw into a very small compass, when they wish to repose. The general division is into those which have tails, and those which have none. There are twenty-five species.

**VESSEL**, a general name given to all the different sorts of ships which are navigated in the ocean, or in canals and rivers. It is, however, more particularly applied to those of the smaller kind, furnished with one or two masts.

**VESTIBULE**, in Architecture, a kind of entrance into a large building; being a place before the hall, or at the bottom of the staircase.

**VESTRY**, a place adjoining to a church, where the vestments of the minister are kept; also a meeting at such place where the minister, churchwarden, and principal men of most parishes, at this day make a parish vestry.

**VESUVIAN**, a mineral found in lava, especially at Vesuvius, and formerly confounded with hyacinth. Its colour is brown or greenish. It is found in masses, but usually crystalized in rectangular eight-sided prisms. The primitive form of its crystal is the cube. The specific gravity is from 3·39 to 3·4.

**VIBRATION**, in Mechanics, a regular reciprocal motion of a body, as a pendulum, &c. which, being freely suspended, swings, or oscillates, first this way, then that.

**VICAR**, one who supplies the place of another. The priest of every parish is called rector, unless the prædial tithes are appropriated, and then he is styled vicar, and when rectories are appropriated, vicars are to supply the rector's place. Prior to the Reformation, when the patronage of a parish was in the hands of a religious house, the monks usually detained the larger portion of the tithes, and appropriated a certain portion for the support of the vicar whom they appointed to perform the duties. Such tithes are now enjoyed by the vicar, and the other tithes by the lay impropriator, or other parties who inherit the property of the religious houses.

**VICE**, in Smithery, and other arts employed in metals, is a machine or instrument, serving to hold fast any thing they are at work upon, whether it is to be filed, bent, riveted, &c.

Vice, *Hand*, is a small kind of vice serving to hold the lesser works, that require often turning about.

Vice is also a machine used by the glaziers to turn or draw lead into flat rods, with grooves on each side to receive the edges of the glass.

**VILLAIN**, or Villein, in our ancient customs, denotes a man of servile and base condition, *viz.* a bondman or servant; and there were anciently two sorts of bondmen or villains in England; the one termed a villain in gross, who was immediately bound to the person of his lord and his heirs; the other, a villain regardant to a manor, he being bound to his lord as a member belonging and annexed to the manor whereof the lord was owner; and he was properly a pure villain, of whom the lord took redemption to marry his daughter, and to make him free; and whom the lord might put out of his lands and tenements, goods and chattels, at his will, and beat and chastise, but not maim him.

**VINEGAR**, is a liquid of a reddish or yellowish colour, a pleasant sour taste, and an agreeable odour. Its specific gravity varies from 1·0135 to 1·0251, and it differs also in its other properties, according to the liquid form in which it has been procured. It is very subject to decomposition; but Scheele discovered that if it is made to boil for a few moments, it may be kept afterwards for a long time without alteration. Besides acetic acid and water, vinegar contains several other ingredients, such as mucilage, tartar, a colouring matter, and often also two or more vegetable acids. When distilled at a temperature not exceeding that of boiling water, till about two-thirds of it have passed over, all these impurities are left behind, and the product is pure acid diluted with water. *See* ACID and CHEMISTRY.

**VINERY**, in Gardening, a sort of garden erection, consisting of a wall twelve or fourteen feet high, extending from east to west, furnished with stoves, flues, a roof, and lights of glass, for the protection and cultivation of vines. The double vinery, in the Plate, is an improvement on the old system, the advantages of which must appear obvious on inspection. The buildings will be attended with some additional expense; but wherever a trial has been made, the experiment has fully answered every reasonable expectation.

**VINEYARD**, a plantation of vines.

**VIOL**, among sailors, the anchor rope, as it is thus pronounced, but which is more generally spelt *voyol.* This name is more particularly applied to a thick rope, which being attached to the cable, passes through a large block, and thence to the fore capstan: when it goes direct from the cable to the main capstan, it is more usually called the messenger.

VIOL, a stringed instrument, resembling in shape and tone the violin, of which it was the origin; that impressive and commanding instrument being little more than an improvement of the old viol.

**VIOLA**, a tenor violin. This instrument is similar in its tone and formation to the violin, but its dimensions are somewhat greater, and its compass a fifth lower in the great scale of sounds.

**VIOLIN**, or FIDDLE, a well-known stringed instrument, of brilliant tone and active execution. The four strings of which it consists, are tuned in fifths from each other. The pitch of the lowest string is G, under the second ledger line in the treble stave; consequently that of the next is D, under the first line of the stave; the pitch of the next above that, A on the second space; and that of the upper string, E on the fourth space.

**VIOLONCELLO**, a bass viol, containing four strings, the lowest of which is tuned to double C. The strings are in fifths, consequently the pitch of that next the gravest is C gamut; that of the next, D on the third line in the bass; and that of the upper string, A on the fifth line.

**VISION.** *See* OPTICS.

**VITAL AIR.** Pure air or oxygen, is one of the constituent parts of atmospherical air, and is useful in the germination of grain and seeds, the vegetation and growth of plants, and is essential to the support of animal life. In reference to the latter, it is inhaled by respiration; but on the nature of its operation there have been many theories, each of which has its advocates and followers, without being supported by conclusive arguments, or established on incontrovertible principles.

**VITRIFICATION.** *See* GLASS.

**VITRIOL**, MARTIAL, or *Sulphat of Iron.* In commerce it is usually denominated green vitriol or copperas. It is not prepared by dissolving iron in sulphuric acid, but by moistening the pyrites, which are found native in abundance, and exposing them to the open air. They are slowly covered with a crust of sulphat of iron, which is dissolved in water, and afterwards obtained in crystals by evaporation. Sometimes the salt is found ready-formed, either in a state of solution in water, or mixed with decayed pyrites. In some cases it is found necessary to roast the pyrites before they can be made to undergo spontaneous decomposition. Sulphat of iron has a fine green colour. Its crystals are transparent rhomboidal prisms, the faces of which are rhombs, with angles of 79 deg. 50 min. and 100 deg. 10 min. inclined to each other at angles of 98 deg. 37 min. and 81 deg. 23 min. It has a very strong styptic taste, and always reddens vegetable blues. Its specific gravity is 1·8399. It is soluble in about two parts of cold water, and in $\frac{3}{4}$ths of its weight of boiling water. It is insoluble in alcohol.

**VOLCANO**, in Natural History, a burning mountain, or one that occasionally vomits forth fire, flame, ashes, cinders, &c. Volcanoes are peculiar to no climate, and have no necessary connexion with any other mountains, but seem to have some with the sea, being generally in its neighbourhood; they frequently throw out matter which belongs to the sea, as the relics of fishes, sea-weed, and sometimes sea-water itself. The most celebrated volcanoes are those of Etna and Vesuvius.

**VOLCANOES IN THE MOON.** As the moon has on its surface mountains and valleys in common with the earth, some modern astronomers have discovered a still greater similarity, *viz.* that some of these are really volcanoes emitting fire as those on the earth do. An appearance of this kind was discovered some years ago by Don Ulloa in an eclipse of the sun. It was a small bright spot, like a star, near the margin of the moon, and which he at that time supposed to have been a hole, with the sun's light shining through it. Succeeding observations, however, have induced astronomers to attribute appearances of this kind to the eruption of volcanic fire; and Dr. Herschel has particularly observed several eruptions of the lunar volcanoes.

**VOLLEY** of SMALL ARMS, a discharge of several muskets at the same instant.

**VOLTAISM.** *See* GALVANISM.

**VOLUNTEER**, implies a man who, being in the king's service, freely offers himself to serve in a particular expedition of danger and fatigue.

**VOLUTE**, a spiral scroll, used in the Ionic and Composite capitals, whereof it makes the principal characteristic and ornament.

**VORTEX**, a whirlwind, or sudden rapid or violent motion of the air in gyres or circles. Sometimes it implies an eddy or whirlpool, or a body of water, in certain seas, or rivers which runs rapidly around, forming a sort of cavity in the middle.

VORTEX, in the Cartesian philosophy, is a system or collection of particles of matter, moving the same way, and round the same axis.

**VOWEL**, in Grammar, a letter which affords a complete sound in itself. In our language there are six in number, *a, e, i, o, u*, and *y*.

**VOYAGE**, any distance passed, or to be passed, at sea.

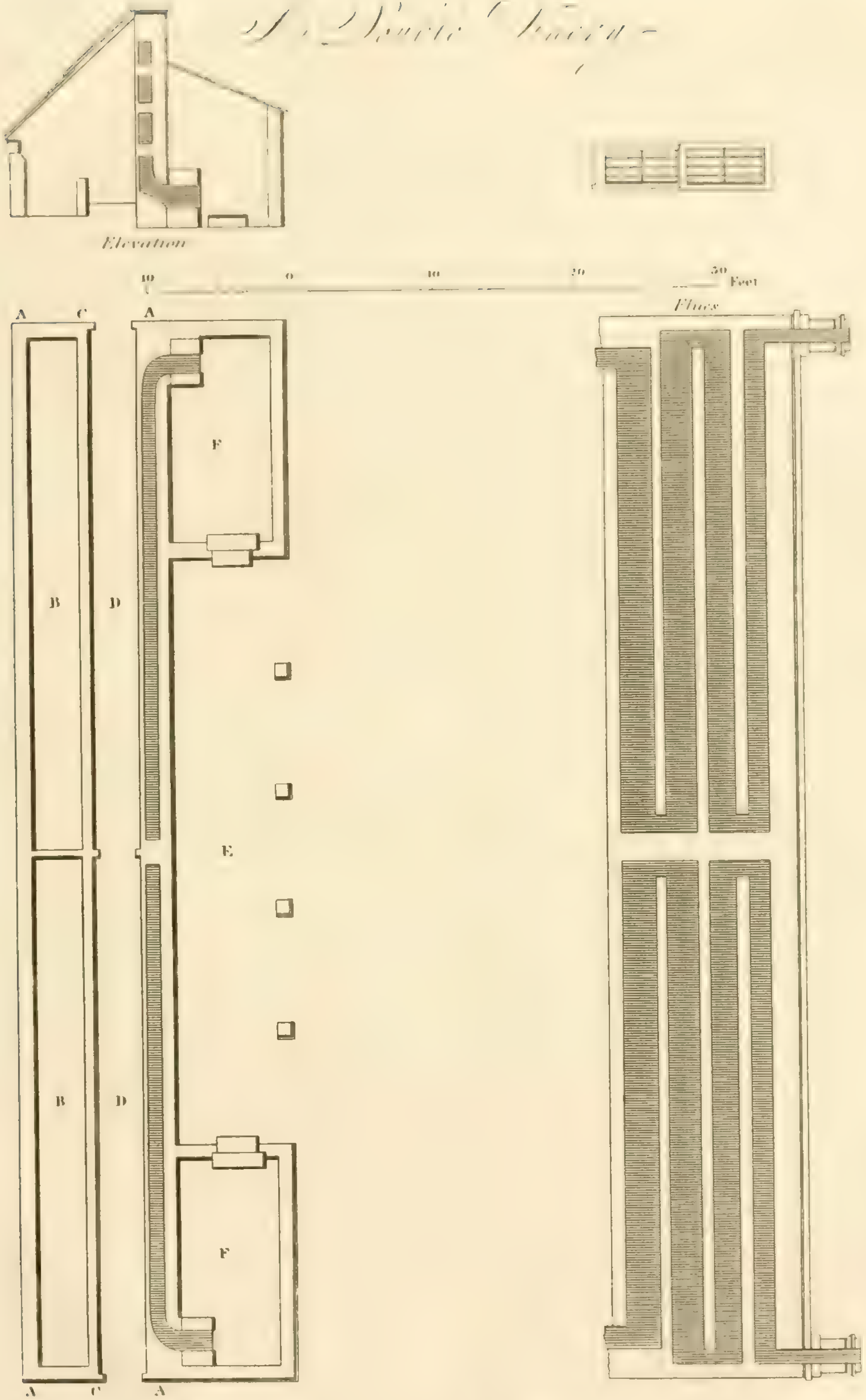
**VULCANIC THEORY OF THE EARTH.** This theory, also called Plutonic, in opposition to the Neptunian theory, (which supposes all matter to have formerly been dissolved in a fluid, and to have gradually been deposited in the forms in which we now find it,) supposes, that, formerly the world was in a fluid state, by the power of heat; on the abatement of which, rocks became solid; and that the inequalities of surface of hills and mountains have been caused by the force of internal fire elevating them above the common level. It assumes that, at great depths in the mineral regions, an immense heat is constantly present, and that this heat operates in the fusion and the consolidation of the substances deposited. To the action of this heat, the formation of all our strata is attributed. They are conceived to be the wrecks of a former world, which have been more or less perfectly fused by this agent, and by subsequent cooling have been consolidated. The subterraneous fire being placed at immense depths, the substances on which it operates must be under a vast pressure. This prevents their volatilization in whole or in part, and from this circumstance it explains appearances, in minerals and qualities, which they possess, which would otherwise appear inconsistent with the supposition of their being formed by fire.

**VULGATE**, a very ancient Latin translation of the Bible, and the only one the church of Rome acknowledges authentic. It is by St. Jerome, and was made almost word for word from the Greek of the LXX. The author of the version is not known, nor so much as guessed at.

*Vulgate of the New Testament.*—This the Romanists generally hold preferable to the common Greek text, in regard it is this alone, and not the Greek text, that the Council of Trent had declared authentic. Accordingly that church has, as it were, adopted this edition. The priests read no other at the altar, the preachers quote no other in the pulpit, nor the divines in the schools.

**VULTUR**, the *Vulture*, in Natural History, a genus of birds of the order accipitres.

# A Double Vinery.



A Front and Back Walls

B Pits for a Crop of Figs or Peaches in Pots, and Mushrooms under them. To be filled with fresh Dung at the beginning of forcing the Vines, which will be of essential service to the Vines and ensure a crop.

C. Stone Parapet.

D Border for the Vines to run in.

The Fruit to grow against the Back Wall

Grapes fit for cutting in April and May

E. Open Shed behind the Vines. F Fire Houses.

# W.

W, is the twenty-first letter of our alphabet.

**WACKEN**, a mineral that occurs in mass; sometimes it forms strata, but more frequently it runs in veins. Colour dark greenish-gray, which often passes to mountain-green, or blackish-green. Specific gravity from 2·5 to 2·9. Easily melts before the blowpipe.

**WAD**, or **Wadding**, in Gunnery, a stopple of paper, hay, straw, old rope-yarn, or tow, rolled up like a ball, or a short cylinder, and forced into a gun to keep the powder close in the chamber; or put up close to the shot, to keep it from rolling out.

**WAFERS**, **To Make**:—Take very fine flour, mix it with white of eggs, isinglass, and a little yeast; mingle the materials; beat them well together; spread the batter, being made thin with gum-water, on even tin plates, and dry them in a stove, then cut them out for use. You may make them of what colours you please, by tingeing the paste with brazil or vermilion for red; indigo or verditer, &c. for blue; saffron, turmeric, or gamboge, &c. for yellow.

**WAFT**, a signal displayed from the stern of a ship for some particular purpose, by hoisting the ensign furled up together into a long roll, to the head of its staff, or to the mizzen-peek. It is particularly used to summon the ship's boats off from the shore.

**WAGERS.** In general a wager may be considered as legal, if it is not an incitement to a breach of the peace, or to immorality; or if it does not affect the feelings or interest of a third person, or expose him to ridicule; or if it is not against sound policy.

**WAGES**, what is agreed upon by a master to be paid to a servant, or any other person that he hires to do his business for him.

**WAIST**, that part of a ship which is contained between the quarter-deck and forecastle, being usually a hollow space, with an ascent of several steps to either of those places. When the waist of a merchant ship is only one or two steps of descent from the quarter-deck and forecastle, she is said to be galley-built; but when it is considerably deeper, as with six or seven steps, she is called frigate-built.

**Waist** *Cloths*, coverings of canvass or tarpauling for the hammocks, which are stowed on the gangways, between the quarter-deck and forecastle.

**WAISTERS**, people stationed in the waist in working the ship; and as they have little else of duty but pulling and hoisting, they are, for the most part, selected from the strongest landsmen and ordinary seamen.

**WAKE** of a **Ship**, the smooth water astern when she is under sail; this shews the way she has gone in the sea, whereby the mariners judge what way she makes. For if the wake is right astern, they conclude she makes her way forward, but if the wake is to leeward a point or two, then they conclude she falls to the leeward of her course.

**WALE**, or **Wales**, in a Ship, those outermost timbers in a ship's side, on which the sailors set their feet in climbing up. As the wales are framed of planks broader and thicker than the rest, they resemble ranges of hoops encircling the sides and bows. They are usually distinguished into the main-wale and the channel-wale; the former is below the lower-deck ports, and the latter between the top of those ports and the sills of the upper-deck ports. The situation of the wales being ascertained by no invariable rule, is generally submitted to the judgment and fancy of the builder; but the position of the gun-ports and scuppers ought to be particularly considered, that the wales may not be wounded by too many breaches.

**WALES**, **William**, a respectable mathematician, who accompanied Cook in his first voyage round the world, as astronomer, and was afterwards appointed mathematical master at Christ's hospital. He was author of an Account of Astronomical Observations in the Southern Hemisphere, 4to.; &c. Wales died in 1799.

**WALLIS**, Dr. **John**, an eminent English mathematician, was born at Ashford in Kent, in 1616, and died in Oxford in 1703, in the 88th year of his age. Dr. Wallis was the author of several ingenious and learned works, on various branches of the mathematics.

**WALL-SIDED**, the figure of a ship's side when, instead of being incurvated, so as to become gradually narrower towards the upper part, it is nearly perpendicular to the surface of the water, like a wall. In ship-building, this was formerly called wall-reared.

**WAPENTAKE**, from the Saxon, the same with what we call a hundred, and more especially used in the northern counties beyond the river Trent.

**WAR.** The too frequent recurrence of this great and detestable calamity, unfortunately renders a definition of the word unnecessary. If we were called upon to define it, we would say, it is the wanton destruction, the cold-blooded slaughter, of the human race: we should call it an accumulation of every sin that degrades and vilifies mankind: we should mark it as a practice that diffuses misery, and perpetuates vice; we should say, that if there is a burlesque upon the boasted reason of man, it is this—when millions meet to murder each other for a quarrel, in which, in general, they have not individually the smallest interest. The poet who wrote

> "One murder makes a villain, millians a hero," &c.

deserves a statue of gold; and the writer of that verse may lift his head in the proudest assembly, and avow his principles in the face of the world.

**WARDEN**, one who has the charge of keeping of any person or thing by office.

**WARDMOTE**, in London, is a court so called which is kept in every ward of the city.

**WARE**, (To) or **Wear**, to cause a ship to change her course from one board to the other, by turning her stern to the wind. Hence it is used in the same sense of veering, and in opposition to tacking, wherein the head is turned to the wind, and the stern to leeward. Since by this movement the ship loses considerably more ground than by tacking, it is rarely practised, except in cases of necessity, or for delay, as when the violence of the wind and sea renders tacking impracticable, or when the course is slackened to wait for a pilot, or for some other ship, &c. In order to wear or veer the ship, the after sails are brailed up, or made to shiver in the wind, whilst the head sails are increased, the helm being put hard a-weather, or to windward: by which means the forepart is turned about from the wind; but as soon as the wind will act upon that quarter, which was before to leeward, the after sails must be extended so as to receive the greatest impulse, whilst the head sails are braced obliquely, whereby the vessel will wheel round, with her bow to windward, and become close-hauled upon the contrary tack to that on which she formerly stood. When the tempest is so violent as to prevent the use of sails, the effort of the wind operates almost equally on the opposite ends of the ship, so that the masts and yards situated at the head and stern counterbalance each other. The effect of the helm is also considerably diminished; because the head way, which gives life and vigour to all its operations, is at this time feeble and ineffectual. Hence it is necessary to destroy this equilibrium, which subsists between the mast and yards afore and abaft, and to throw the balance forward in order to prepare for veering or wearing. This is accordingly performed by bracing the foremost yards across the direction of the wind, and arranging those on the main mast and mizzen mast directly in the line of the wind. If this expedient proves unsuccessful, and it is absolutely necessary to wear, in order to save the ship from destruction by oversetting or running ashore, the mizzen mast must instantly be cut away, and even the main-mast, if she yet remains incapable of answering by bearing away before the wind.

WARP, in the Manufactures, is the threads, whether of silk, wool, linen, hemp, &c. that are extended lengthwise on the weaver's loom; and across which the workman by means of his shuttle passes the threads of the woof, to form a cloth, riband, fustian, or other stuff.

Warp, a rope or hawser, employed occasionally to remove a ship from one place to another in a port, road, or river. Hence, *To Warp*, is to change the situation of a ship, by pulling her from one part of a harbour, &c. to some other, by means of warps which are attached to buoys, to other ships, to anchors sunk in the bottom, or to certain stations upon the shore, as posts, rings, trees, &c.

WARRANT, a præcippe, under hand and seal, to bring any offender before the person granting it; and warrants of commitment are issued by the privy council, a secretary of state, or justice of the peace, &c. when there has been a private information, or a witness has deposed against an offender. A warrant from any one of the justices of the Court of King's Bench extends over all the kingdom, and is tested or dated England, but a warrant of a justice of peace in one county, must be backed, that is, signed, by a justice of another county, before it can be executed there; and a warrant for apprehending an English or a Scotch offender, may be indorsed in the opposite kingdom, and the offender carried back to that part of the united kingdom in which the offence was committed. This is also now extended to Ireland, upon a proper certificate of an indictment or information filed in either country.

Warrant *of an Attorney*, is an authority and power given by a client to his attorney, to appear or plead for him; or to suffer judgment to pass against him by confessing the action by "nil dicit, non sum informatus, &c."

Warrant, the name given to a kind of commission or authority to those officers appointed by the Navy-Board, while the authorities granted by the Admiralty are styled commissions. Hence, a *Warrant Officer*, is an officer holding a warrant from the Navy-Board; such are the master, surgeon, purser, boatswain, gunner, carpenter, &c.

WARRANTY, a promise or covenant by deed, made by the bargainer, for himself and his heirs, to warrant or secure the bargainee and his heirs against all men, for the enjoying any thing agreed on between them.

WARREN, is a franchise, or place privileged by prescription or grant from the king, for the keeping of beasts and fowls of the warren; which are coneys, partridges, pheasants, &c.

WASH, among Distillers, the fermentable liquor used by malt distillers.

Wash *Board*, a broad thin plank, fixed occasionally on the top of a boat or other small vessel's side, so as to increase the height thereof, but may be removed at pleasure. It is used to prevent the sea from breaking into the vessel in rough weather.

WASTE, is the committing of any spoil or destruction in houses, lands, &c. by tenants, to the damage of tne heir, or of him in reversion or remainder; whereupon the writ or action of waste is brought for the recovery of the thing wasted, and damages for the waste.

WATCH, a small portable machine for measuring time; having its motion commonly regulated by a spiral spring. Perhaps, strictly speaking, watches are all such movements as shew the parts of time; as clocks are such as publish them by striking on a bell, &c. But commonly the term watch is appropriated to such as are carried in the pocket; and clock to the large movements, whether they strike the hour or not.

*Spring* or ***Pendulum*** Watches, stand pretty much on the same principle with pendulum clocks. For if a pendulum describing small circular arcs, make vibrations of unequal lengths in equal times, it is because it describes the greater arc with a greater velocity; so a spring put in motion, and making greater and less vibrations as it is more or less stiff, and as it has a greater or less degree of motion given it, performs them nearly in equal times. Hence, as the vibrations of the pendulum had been applied to large clocks, to rectify the inequality of their motions; so to correct the unequal motions of the balance in watches, a spring is added, by the isochronism of whose vibrations the correction is to be effected. The spring is usually wound into a spiral; that, in the little compass allotted it, it may be as long as possible; and may have strength enough not to be mastered, and dragged about by the inequalities of the balance it is to regulate. The vibrations of the two parts, viz. the spring and the balance, should be of the same length; but so adjusted, as that the spring, being more regular in the length of its vibrations than the balance, may occasionally communicate its regularity to the latter.

*Striking Watches*, are such as, besides the proper watch-part adapted to the measuring of time, have a clock part for striking the hours, &c.

*Repeating Watches*, are such as by pulling a string, &c. repeat the hour, quarter, or minute, at any time of the day or night.

*Of the Mechanism of a Watch*, properly so called. Watches, as well as clocks, are composed of wheels and pinions, and a regulator to direct the quickness or slowness of the wheels, and of a spring which communicates motion to the whole machine. But the regulator and spring of a watch are vastly inferior to the weight and pendulum of a clock, neither of which can be employed in watches. Instead of a pendulum, therefore, we are obliged to use a balance (plate, fig. 1,) to regulate the motion of a watch; and a spring, fig. 2, which serves instead of a weight to give motion to the wheels and balance.

The wheels of a watch, like those of a clock, are placed in a frame formed of two plates and four pillars. Fig. 3, represents the inside of a watch, after the plate, fig. 4, is taken off. A is the barrel which contains the spring, fig. 2; the chain is rolled about the barrel, with one end of it fixed to the barrel A, fig. 5, and the other to the fusee B.

When a watch is wound up, the chain which was upon the barrel winds about the fusee, and by this means the spring is stretched; for the interior end of the spring is fixed by a hook to the immoveable axis about which the barrel revolves; the exterior end of the spring is fixed to the inside of the barrel, which turns upon an axis. It is therefore easy to perceive how the spring extends itself, and how its elasticity forces the barrel to turn round, and consequently obliges the chain which is upon the fusee to unfold and turn the fusee; the motion of the fusee is communicated to the wheel C, fig. 5; then by means of the teeth to the pinion *c*, which carries the wheel D; then to the pinion *d*, which carries the wheel E; then to the pinion *e*, which carries the wheel F; then to the pinion *f*, upon which is the balance wheel G, whose pivot runs in the pieces A called the potance, and B called a follower, which are fixed on the plate fig. 4. This plate, of which only a part is represented, is applied to that of fig. 3, in such a manner that the pivots of the pinions enter into holes made in the plate, fig. 3. Thus the impressed force of the spring is communicated to the wheels; and the pinion *f* being then connected to the wheel F, obliges it to turn fig. 5. This wheel acts upon the palettes of the verge 1, 2, fig. 1, the axis of which carries the balance H H, fig. 1. The pivot I in the end of the verge, enters into the hole *c* in the potance A, fig. 4. In this figure the palettes are represented; but the balance is on the other side of the plate, as may be seen in fig. 6. The pivot 3 of the balance enters into a hole of the cock B C, fig. 7, a perspective view of which is represented in fig. 8. Thus the balance turns between the cock and the potance *c*, fig. 4, as in a kind of cage. The action of the balance wheel upon the palettes 1, 2, fig. 1, is the same with what we have described with regard to the same wheel in the clock *i. e.* in a watch, the balance wheel obliges the balance to vibrate backwards and forwards like a pendulum. At each vibration of the balance, a palette allows a tooth of the balance wheel to escape; so that the quickness of the motion of the wheels is entirely determined by the quickness of the vibrations of the balance; and these vibrations of the balance and motion of the wheels are produced by the action of the spring.

But the quickness or slowness of the vibrations of the balance depends not solely upon the action of the great spring, but chiefly upon the action of the spring *a*, *b*, *c*, called the spiral spring, fig. 9, situated under the balance H, and represented in perspective, fig. 6. The exterior end of the spiral is fixed to the pin *a*, fig. 9. This pin is applied near the plate in *a*, fig. 6; the interior end of the spiral is fixed by a peg to the centre of the balance. Hence if the balance is turned upon itself, the plates remaining immoveable, the spring will extend itself, and make the balance perform one revolution. Now, after the spiral is thus extended, if the balance be left to itself, the elasticity

# Mechanism of the Common Watch

Fig. 1

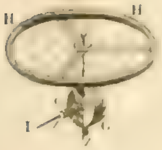


Fig. 2

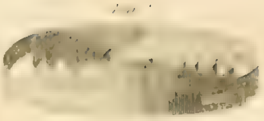


Fig. 3

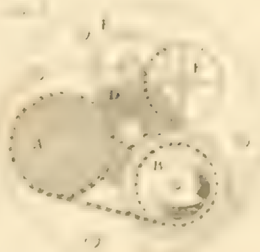


Fig. 4

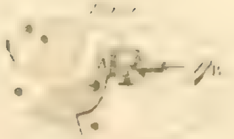


Fig. 5

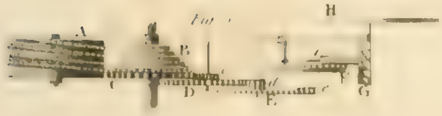


Fig. 6

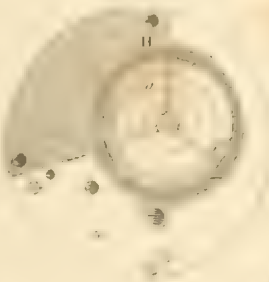


Fig. 7

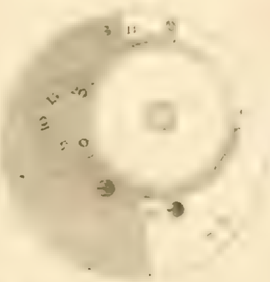


Fig. 8

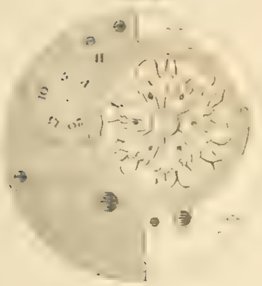


Fig. 9

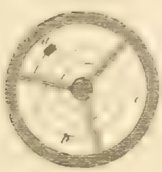


Fig. 10

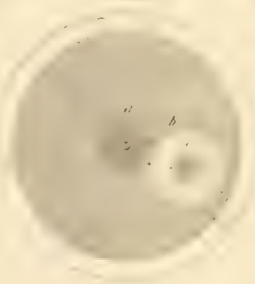
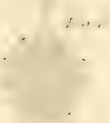


Fig. 11



# Yarn - Mill p 1060.

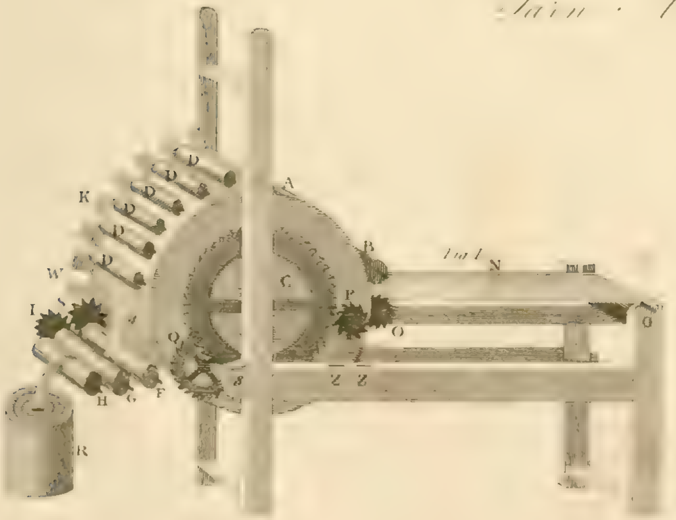


Fig. 1

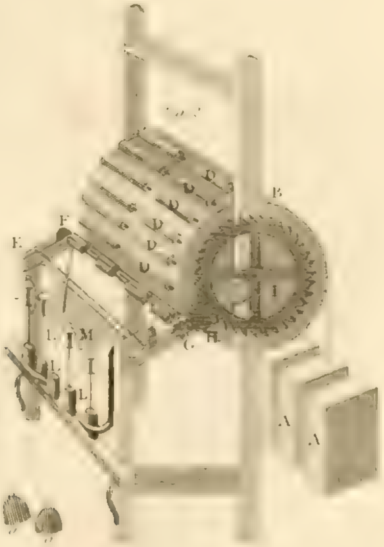
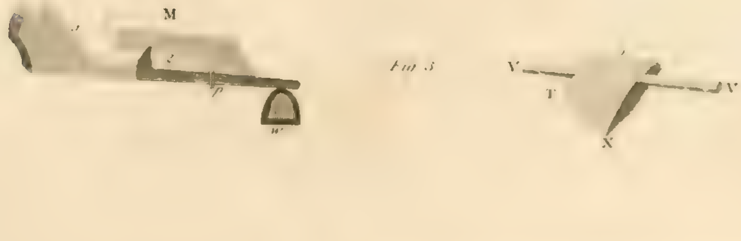
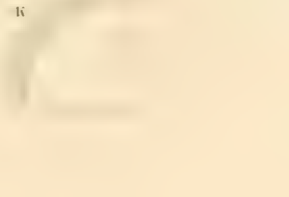


Fig. 2

Fig. 3





of the spiral will bring back the balance, and in this manner the alternate vibrations of the balance are produced.

In fig. 5, all the wheels above described are represented in such a manner, that it may be easily perceived at first sight how the motion is communicated from the barrel to the balance.

In fig. 10 are represented the wheels under the dial-plate by which the hands are moved. The pinion *a* is adjusted to the force of the prolonged pivot of the wheel D, fig. 5, and is called a cannon pinion. This wheel revolves in an hour. The end of the axis of the pinion *a*, upon which the minute hand is fixed, is square; the pinion fig. 10 is indented into the wheel *b*, which is carried by the pinion *a*. Fig. 11, is a wheel fixed upon a barrel, into the cavity of which the pinion *a* enters, and upon which it turns freely. This wheel revolves in twelve hours, and carries along with it the hour-hand.

Such in brief is the general mechanism of a watch; to treat the subject to the extent its importance demands would require a volume: some parts of the construction are further explained under the words Balance and Scapement in this volume.

Mr. Elliot of Clerkenwell has lately invented a very simple repeating watch, in which the motion is performed with much fewer parts than in the usual construction, by which means he is enabled to reduce the price so low as eight guineas for a good repeater on this principle, or to add the repeating work to another watch for three.

The method by which this repeater is so much simplified is by the use of a single part, so contrived as to perform the operations of several: this is a flat ring, or centreless wheel, of nearly the same diameter as the watch, supported in its place, so as to admit of circular motion, by four grooved pulleys placed round its external circumference, in the same manner as the part in common clocks which denotes the moon's age. This part is put in motion by turning the pendant, whose extremity is formed into a small vertical wheel, which works in teeth cut on the external part of the flat ring for almost a third of its circumference. The lower part of the ring contains the pins, at right angles to its face, which lift the hammers for striking the hours and quarters; the internal part of the ring contains indentations of regularly increasing depths, which receiving the tails of the levers, whose other extremities are pressed by their springs against the hour snail and the quarter-snail, is by them prevented from moving beyond a certain degree proper for the time: after the pendant is turned, the ring is brought back to its first position, by a box spring, round which a fine chain is coiled, whose extremity is connected with the inner part of the ring. By turning the pendant to the left the hour is struck, and by turning it to the right the quarters are repeated; and the returning spring just mentioned is made to operate in both directions, by its chain passing between two little pulleys, which on either side convert the direction of the chain to the line of traction of the spring. Hence it is evident this single flat ring performs all the following operations. 1. It receives the motion for striking the hour from the pendant. 2. The same for striking the quarters. 3. It carries the pins or teeth, which lift the hour-hammer. 4. The same for the quarter-hammer. 5. It contains the indentations by which the hour snail operates on it by its lever. 6. The same by which the quarter-snail operates on it. 7. It carries the part that recoils the movement which tells the hour to its first position. 8. It carries the part for the same purpose, for the quarter movement. 9. It contains a cavity, which moves over a fixed pin, that prevents the pendant from turning it too far. In this ring, the same parts in three instances are made to perform double operations, by which simplicity of construction is advanced, apparently, to its greatest extent.—*Dr. Gregory's Mechanics.*

Watch, in the art of War, a number of men posted at any passage, or a company of the guards who go on the patrol. At sea, the term watch denotes a measure or space of four hours, because half the ship's company watch and do duty in their turns, so long at a time, and they are termed starboard watch, and larboard watch. These epithets allude to the situation of their hammocks when hung up; the two watches are, however, occasionally separated into three or four divisions, as in a road, for an anchor-watch, &c. But the officers of the navy usually divide themselves into three watches, in order to lighten their duty.—Starboard Watch, Hoay! Starbow Lines, Hoay! Larboard Watch, Hoay! Larbow Lines, Hoay! are exclamations used by the boatswain's mates when summoning their respective watches upon deck, to relieve each other.

*Anchor* Watch, is a small guard kept constantly upon deck, while the ship rides at single anchor. *Dog Watches*, are the two reliefs which take place between four and eight o'clock in the afternoon, each of which is only two hours; the intent of these watches is to change the turn of the night watch every twenty-four hours. The *First Watch*, is from eight o'clock in the evening till twelve at night. The *Middle Watch* continues from twelve till four in the morning. The *Morning Watch* comprehends from four to eight o'clock in the morning. See *Nautical* Day, p. 214. A buoy is said to watch, when it continues floating upon the surface of the sea.

Watch, is also a word used in throwing the deep-sea lead, when each man, on letting go the last turn of line in his hand, calls to the next abaft him "Watch."

Watch *Glasses*, are the glasses employed to measure the period of the watch, or to divide it into any number of equal parts, as hours, half-hours, &c. so that the several stations therein may be regularly kept and relieved, as at the helm, pump, look-out, &c. See the article Glass.

WATCHMAN'S Noctuary, the name given to an instrument lately contrived to remedy a great defect in an important branch of the police of great cities, that of night-watching. Every twenty-four hours furnishes some instance of the inefficacy of the present system, by the depredations which have been committed in the night, or by the fatal accidents which occur from a neglect of giving families timely warning in cases of sudden fires. A respectable magistrate (Samuel Day, Esq. of Charter House, Hinton, Somersetshire) has directed his attention to the application of a mechanical check upon the diligence and regularity of watchmen, labourers, and all other classes of men whose duty requires that they should attend at certain places at appointed times; the instrument he has invented for this purpose he calls a *Watchman's Noctuary*, or *Labourer's Regulator*.

The invention consists principally of a large horizontal wheel, which is moved uniformly round every twelve hours by clock-work. The upper side of this wheel is divided by two circles, one within the other; the outer one, or periphery, having the hours and quarters marked on it, which may be called the lateral side; the inner circle having also a dial, which may be called the vertical one. The space between these circles or dials is divided into cells, each cell corresponding with a quarter or half-hour of the different hours marked on the dials; and if thought proper, the cells might be so multiplied, as that each would correspond within a period of five minutes. Such is the upper side of the horizontal wheel, which may be made of copper, or tin, or various other materials, and is about 9 inches in diameter. The under side of the same has a brass wheel with teeth, diameter 3¼ inches, fixed to its central part; the teeth of which, letting in with those of a smaller wheel or pinion, give motion in consequence to the large horizontal wheel (of which it forms a part) by the motion it receives from the pinion. This pinion being set in motion by the common clock-work and a weight or spring, the revolution of the horizontal wheel is completed once in twelve hours, and thus regularly going round, will at all times shew the time of day or night. As it moves round it carries the cells above mentioned under a kind of chink, just large enough to receive a token of about the size of a farthing. This chink sinks down from an external brass box, which is sufficiently large to admit a man's fingers to drop in the token by an external aperture or mouth of the chink, the token being directed perpendicularly through this chink into such cell as is immediately under it, and which must correspond with the time of night or day. The head of the case of the machine has double doors in front; the outward door covers the whole face together, leaving a sufficient space above the horizontal wheel for examining the tokens and taking them from the cells, or for removing the wheel when necessary. A smaller door opens in this large one upon the brass box abovementioned, the opening of which belongs solely to the watchman, or such other person as may be required to use the same, for the purpose of seeing the time and dropping his tokens, a minute dial also being placed under the hour-index. If it be found more convenient, a common dial plate, to shew the hours and minutes, may be placed instead of the minute dial. The great outer door first mentioned is to be opened only by the inspector or examiner of the tokens, and ought to be well secured; but for greater safety, both against thieves and weather, there is an inside door, in which the fore-mentioned brass box is fixed; and this inner door being opened, throws into view the horizontal wheel for the purpose just specified. These are the essential parts of the invention; the different appendages may be variously modified. One such instrument as this being placed at each end of a watchman's round, it will be ascertained how the man continued his movements through the night, to a nicety of ten minutes (or less if required) at any period of the watch; and the slightest irregularity or omission will be detected the next morning by the person whose office it shall be to open the machine. No trick or fraud on the watchman's part can counteract the movement of the horizontal wheel comprising the cells into which the tokens are to be dropped; each cell is, by this contrivance, like time itself, irrevocable when past: the watchman has no command over it, and the whole will be a kind of speaking witness of his diligence and fidelity in going his rounds, answering the next morning to the exact periods he either was or ought to have been there.

The same machine will answer in custom-houses, ware-houses, banking-houses, manufactories, bleaching-grounds, and every place where watching or other attendance, to be useful, must be exact: even sentinels on military duty might be required to leave tokens as memorials of their vigilance.

Mr. Day obtained the usual patent for securing to himself the right of making and selling this instrument; yet surely not to the exclusion of others invented for the same purpose: for the late Marquis of Exeter informed the public years ago, through the medium of Nicholson's Philosophical Journal, that a clock for a similar purpose had been invented by Messrs. Boulton and Watt of Birmingham, which cost no more than thirty shillings. His lordship had then had two of them at Burleigh Hall more than four years; and he gives the following description of them: "They go eight days, and have a face like a clock, but do not strike. The dial goes round, and the hour-finger is fixed: round the edge of the dial are moveable iron pins, corresponding with the quarters in each hour. A small hammer placed behind the hour-finger, when moved downwards, pushes into the dial one of the pins which happens to be under it at the time, which pin remains so abased until the dial nearly returns to the same place, when by an enclosed plane the pin is raised up into its first position. This gives time to have the machine examined in the morning, to see how many pins have been struck, and at what time they were pushed downwards. The hammer is moved by the pulling of a chain with a handle, like house-door bells, which, by cranks and wires, is attached to it. I have one in my library, the handle is out of doors. The other machine is placed in a building at the other end of my premises."

**WATER**, a transparent fluid without colour, smell, or taste; in a very small degree compressible; when pure, not liable to spontaneous change; liquid in the common temperature of our atmosphere, assuming a solid form at 32° Fahrenheit, and a gasseous at 212°, but returning unaltered to its liquid state on resuming any degree of heat between these points; it is capable of dissolving a greater number of natural bodies than any other fluid whatever, and especially those known by the name of the saline; performing the most important functions in the vegetable and animal kingdoms, and entering largely into their compositions as a constituent part.

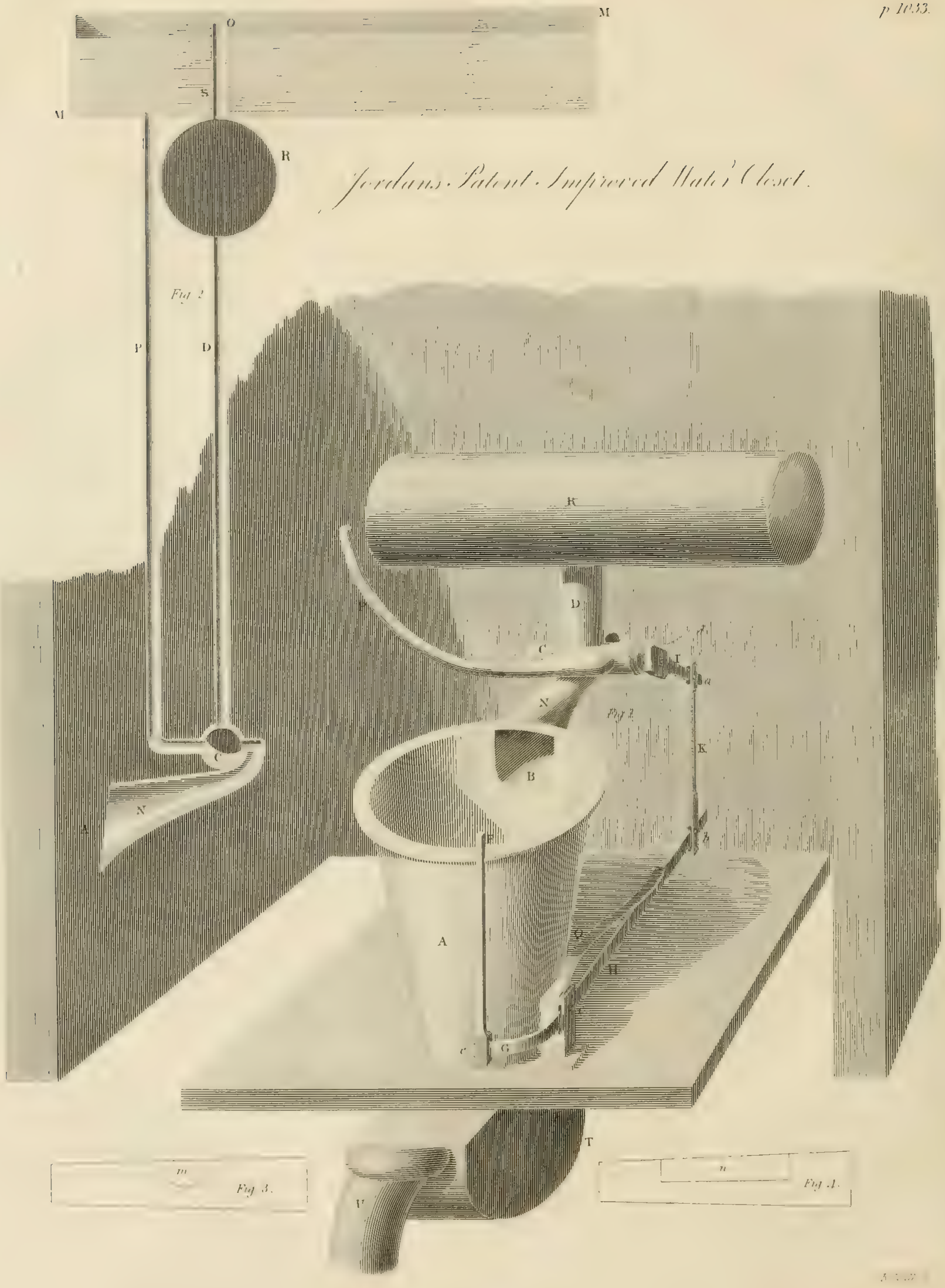
Water exists, therefore, in three different states: in the solid state, or state of ice,—in the liquid,—and in the state of vapour or steam. It assumes the solid form, as observed above, when cooled down to the temperature of 32°, in which state it increases in bulk, and hence exerts a prodigious expansive force, owing to the new arrangement of its particles, which assume a crystalline form, the crystals crossing each other at an angle of 60° or 120°. The specific gravity of ice is therefore less than that of water. When ice is exposed to a temperature above 32°, it absorbs caloric, which then becomes latent, and is converted into a liquid state, or that of water. At the temperature of 42°·5, water is at its maximum of density; and according to some accurate experiments upon water in this state, a French cubic foot of it weighs 70 pounds 223 grains French, which is equal to 529452·9492 troy grains. An English cubic foot, at the same temperature, weighs 437102·4946 grains troy. By professor Robinson's experiments, it is ascertained, that a cubic foot of water, at the temperature of 55°, weighs 998·74 avoirdupois ounces, of 437·5 grains troy each, or about 1¼ ounce less than 1000 ounces avoirdupois, which latter, however, is the usual estimate. When water is exposed to the temperature of 212°, it boils; and if this temperature be continued, the whole is converted into elastic vapour or steam. In this state it expands to about 1800 times its bulk when in the state of water, which shews what an astonishing expansive force it must exert when it is confined; and hence its application to the steam-engine, of which it is the moving power.

*To ascertain the Contraction and Expansion of Water in Cooling.*—Fill a thermometer tube with tepid water, and immerse it in a glass vessel containing water of the same temperature, in which a mercurial thermometer is placed. If the whole apparatus be now placed in a bed of snow, or in a frigorific mixture, the water in the tube will gradually contract, till the mercury shews the temperature of 40°; it will then begin to expand gradually until it becomes ice. From this simple experiment the reader may see, what is otherwise, however, a well established fact, that the specific gravity of water is greatest at 42°. The expansion of this fluid when cooled still further, is an exception to the general law of bodies expanding by heat and contracting by cold; and as we are unable to account for it, or refer it to any class of facts, it seems like a perpetual miracle, and may excite both our wonder and our gratitude whenever it is contemplated. It is in consequence of this miracle that ice swims on water, and does not sink down, choking up the streams and stopping the currents of the rivers, the continued flow of which is as necessary to the existence of the world as the circulation of blood is to our existence.

*Rules for ascertaining the Impurity of Water.* Water is rarely found in a perfectly pure state. It almost invariably contains some portion of earthy, saline, vegetable, animal, or metallic matter, which is derived from the substances over or through which it flows. These substances being more or less held in solution, filtration will of course only separate that which is undissolved and floating in it; ignorant persons should not therefore conclude because water has been filtered, that it is pure and fit for drinking; as it might contain a deadly quantity of lead in solution, and yet be perfectly bright and transparent. Most waters, however, that are turbid only require filtration to render them salubrious. The most certain and direct way of purifying water is by distilling it with some fresh charcoal. The impurity of water may be ascertained by comparing it with that which is known to be pure, or distilled water. Impure water is heavier than pure water. Impure water is thinner, has less fluidity, than pure water. Impure water has some taste, colour, or smell,—pure water has none. Impure water, that contains earthy and metallic salts, is called hard water, being not so soft to the touch as pure water, nor does it wet any substance so readily as pure water. In country places, where water is both plentiful and good, these distinctions may be deemed unimportant; but the impurity of water in some situations is of very serious moment, and felt (we believe) very generally throughout the metropolis. In Christ Church, Surrey, it is a subject of as much complaint, perhaps, as any where. The water as supplied from some of the metropolitan water-works is so grossly impure, that, in the absence of filtering, it can only be safely used in food or drink after it has been boiled, recooled, and allowed to settle for some time—a process which is not only attended with considerable trouble, but which necessarily deteriorates the quality of the water.

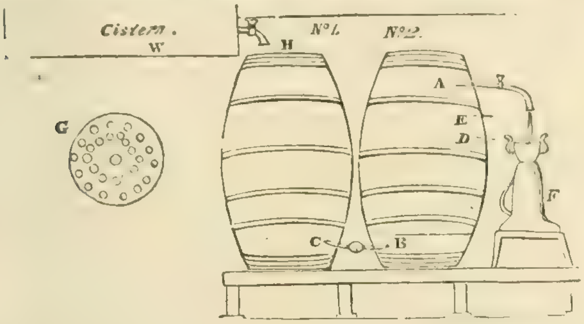
The following is a description of a method of filtering which may easily be adopted: Procure a cask somewhat less than a porter hogshead, but of a different shape, in order to give the better effect to the filtering process, being 40 inches deep on end, and 20 inches in diameter at the top and bottom. Make then a second or false bottom, and perforate it by a three-quarter inch gouge with about 18 holes; groove it into the cask, about four inches from the undermost or real bottom, and cover it over with four plies of coarse flannel. Procure a quantity of coarse

Jordans Patent Improved Water Closet.



fresh-water sand, and with this fill the cask to the height of 20 inches from the false bottom, beating it hard down as it is put in. Above the sand insert another false bottom, perforated like the former, but not grooved into the cask; and over that again lay two plies of flannel. Then add layers of sand and pounded charcoal alternately, for the height of ten inches more, and above these place a lid, perforated and covered with flannel, like the two false bottoms. The six inches of the cask which are now left unoccupied, appropriate to the water to be filtered: a space equal to the reception of from 8 to 10 gallons. On making an experiment with the filter thus constructed, it will be found that the water, however impure when first put in, comes out as clear and sparkling as crystal; and on a continued trial, there may be procured in this way more than twenty gallons of such water every twelve hours. The water may be produced of even greater purity, were it made to percolate upwards instead of downwards; we might, therefore, have our apparatus altered to one of the improved description represented in the annexed sketch.

*Description.*—No. 1 is a cask, 40 inches deep by 20 in diameter, to be filled with water from the cistern W. No. 2, another cask of the same capacity, to contain the filter. B, the first false bottom, perforated and covered with flannel. D, the height to which the cask (No 2,) should be filled with sand, and at which the second false bottom should be inserted. E, the lid, between which and D equal quantities of sand and charcoal are to be interposed. C, communicating cock between the two barrels. A, a cock, to discharge the pure filtered water. F, a vessel to receive the water. G, the false bottom to be grooved into the cask No. 2. H, a ball-cock to regulate the filling of the cask No. 1.



An apparatus of the kind we have described, must obviously have great advantages over any filter that can be made of stone. By removing the upper lid E, whatever refuse may gather on the top, can be skimmed off occasionally. New layers of sand and charcoal, too, can be introduced with great ease, so that the apparatus can with very little trouble be kept at all times in tolerably efficient action, and may at a little expense be renovated entirely, whenever that is found necessary. All the stone filters, on the contrary, that we have ever seen, get rapidly clogged with the earthy deposits from the water, and if not frequently cleaned out, soon cease running altogether. It is deserving of remark, that when the water is suffered to remain in the filter for any considerable time, it is apt to acquire a rank taste. It should be drawn off regularly at short intervals, or, which is better, by the emission of a constant stream.

*Finding of Water by the Divining Rod*, is said to be practised in the following manner:—A green bunch of hazel or thorn is cut with a fork like the letter Y at its upper end; the water finder takes hold of the two prongs of the fork with both hands held together in front of him, keeping the rod in an horizontal position, walking over the ground in this manner where a well is proposed to be sunk. When he comes over the spot where water is to be found, the thick end of the rod is observed to dip so decidedly, that no mistake ever arises from the indication.

WATER CLOSET. *Description of an Improved one, invented by Mr. Jordan, of Norwich.* Essential as water closets are to the cleanliness and comfort of our dwellings, it was not until that extremely simple, but useful contrivance, known by the name of the *water lute*, or, as it is commonly called, the *stink trap*, was applied to them, that the premises could be even partially secured from being annoyed with unpleasant and noisome effluvia. In the country this evil was avoided by placing the water-closet in the garden: but in large towns there was no remedy, except frequent rinsing. But notwithstanding the defence afforded by the water-lute, these indispensable requisites continued to be an annoyance, from the soil sometimes accumulating in the pan of the stink trap, so that the necessity of rinsing with water became frequent—an operation which servants, however urged to it, would often neglect. An apparatus, calculated to perform this office, either by being put into action by the use of the closet, or that might easily be made to act on such an occasion by the hand, was, in consequence, long a desideratum and this desideratum was at last supplied to a certain extent by the late Mr. Bramah, to whom the world is indebted for that most powerful machine, the hydraulic press.

Bramah's water-closet is two well known to need any partilar description in this place, having become one of the appendages, in general use, in all modern mansions; and could the occupiers always count upon their servants possessing even a very small portion of mechanical knowledge, it would have proved more efficient than it has done. But owing to this lack of knowledge, very slight causes, as all builders and plumbers well know, not only impede at times its due action, but expose the premises to be inundated by the continued flow of the cistern or reservoir employed to supply the water, occasioned by any bit of paper or other substance happening to lodge in the valve.

Jordan's water closet requires only to be made known to architects and builders, who may be allowed, generally speaking, to be the most competent judges of the value of any improvement of this nature, to insure its general adoption in all new erections. We have not mentioned as any defect in Mr. Bramah's apparatus, the stretching of the copper-wires that connect the cranks by which action is given to the valve and trap pan, and which stretching at last deranges the apparatus; because it is not a fair objection against any piece of mechanism to say, that in course of time it will need to be repaired. But when another apparatus offers itself to notice, it becomes a matter of common prudence to compare the two in point of durability, as well as general efficiency.—*See the Plate.*

Jordan has taken out a patent for his new apparatus, and the following particulars, extracted from his specification, will make the arrangement and structure of his machine familiar to our mechanical readers. We have only to premise, that where the same letters occur in more than one of the figures of the plate, they refer in both to the same parts. Jordan has discarded from his apparatus the valves, cranks, and connecting wires employed in shutting off or opening the communication between the reservoir and the basin, or soil-pan, in the best water closet now in common use, and instead thereof, he uses what is known among engineers by the name of a *three-way cock*, and also a secondary or intermediate air-tight reservoir, made of copper, or other convenient material, and posited between the main reservoir and the pan or bason. To this cock, action is given by a lever, pressed down a little way by the seat, when the closet is being made use of, which causes the plug of the cock to make about a sixth part of a revolution in its shell or barrel, thereby opening a communication between the main reservoir and the secondary reservoir, and supplying the latter with a sufficient charge of water for the present occasion, while simultaneously, by the same movement of the cock, the communication is shut off between the secondary reservoir and the bason.

In this apparatus, the pan or bason A, fig. 1, is fixed in its place in the usual manner. The water for rinsing it is admitted by the aperture B, from the secondary reservoir R, through the three-way-cock C, which is represented in that position in which it is left after the pressure is removed from the seat, and after the water (having been admitted from the secondary reservoir through the cock C, into the bason or pan A,) has performed its duty—the communication being still open between the pan or bason and the secondary reservoir, which is then empty. For the convenience of description, the pan A is represented without the usual boxing or enclosure, and without either the cover or the sinking seat. Let the seat be conceived to be attached to its place by hinges, in the usual manner, and resting in front on the top of the rod F, then, (as may be seen by inspecting the drawing,) the seat on being pressed down, will cause the rod F to descend, and give motion to the lever G, H, which being connected with the lever or handle I of the three-way cock, by the intermediate rod K, will cause the handle I to describe an arc *a*, *d*, upwards to *d*, pointed to by the dotted outline of the handle or lever I in its elevated position,) and will keep it in that elevated position till the pressure be removed from the top of the rod F, when by the action of the spring Q, it will be brought back to its first situation.

Any machinist will see that different contrivances may be employed to give the requisite action to this part of the apparatus; the patentee, however, does not rest the utility of his invention on the particular structure of the connecting parts of his machinery, but on the employment of the three-way cock in place of the valves and cranks hitherto used in water-closets, and on the employment of his secondary reservoir. But in whatever way motion be given to the plug of the three-way cock to cause it to make about a sixth part of a revolution, as above stated. the communication between the secondary reservoir R, and a pan or bason A, is thereby shut off, and a communication is simultaneously opened between the reservoir R and the supply pipe P, which supply pipe is brought by any convenient course from the main reservoir, wherever it may be situated at some higher position. This last-mentioned communication being now open, the water descends from the main reservoir through the supply-pipe P, passes through the cock C and the pipe D, and then ascends into the secondary reservoir R, by which a degree of compression is given to the air contained therein, proportioned to the greater height of the water in the main reservoir. During the time that a person is on the sinking seat, the secondary reservoir receives its charge of water in the manner just mentioned, and is put in readiness to have the same discharged with considerable velocity, by the elasticity of the confined air, whenever the person rises from the seat; the compressed air, by its elastic force, then urging the water through the aperture B into the pan A, whence it removes the soil through the stink-trap T, to the soil pipe U, to be carried off to the cess pool.

The foregoing is what the patentee calls the more favourable arrangement and form of his apparatus—he prefers and adopts, however, another construction when circumstances will permit it, that is, when the main reservoir is sufficiently elevated to press the air contained above the surface of the water in the secondary reservoir, with the weight of a column of water of about ten or twelve feet in height. But when the main reservoir is not sufficiently elevated to give that degree of compression to the air which is required for an efficient quick expulsion of the water, he places the secondary reservoir as high as circumstances will permit, (four or five feet at least, but more if possible,) that he may establish a column of water between it and the pan A, to act by its mere weight as an impelling power, (when the cock C is put in its requisite position.) to force the water to pass from the secondary reservoir into A, with a proportioned velocity. That is, in this place he does not employ it air-tight, but open to the atmosphere.

That this may be the more easily understood, see plate, fig. 2, in which the communication is open between the secondary reservoir and the injection pipe N, the water being discharged, or having been injected through the pipe N into the pan or bason at A, by its own weight, under the common pressure of the atmosphere, acting upon it at the open orifice of the pipe or tube S, which ascends from the secondary reservoir through the main reservoir M M, almost to its top, which is open to the atmosphere. This pipe S answers also another good purpose, in certain circumstances; namely, when the main reservoir M M receives its supply from any source which at particular times, or by any accident, may cause an overflow, (and which often causes great damage,) the tube or pipe S then serving as a waste pipe to carry off the surplus waste through the secondary reservoir R, the pipe D, the cock C, and the injection pipe N, all of which, as has already been stated, are open so long as the sinking seat is not pressed on—that is, in other words, so long as the rod F (fig. 1,) is not depressed in such a manner as to turn the handle of the cock C, into the position marked by the dotted outline thereof. And here let it be observed, that as often as the position of the plug is altered, by depressing the end G, and elevating the end H of the lever G H, fig. 1, the cock is brought back again to its former position by the action of the spring Q, as soon as the pressure is removed from the top of the rod F.

We need hardly notice, what is common to every similar combination of parts, namely, that the usual means of simple joints are employed in the said apparatus to facilitate motion, where necessary, at the junctions of the levers and rods, as at *a*, *b*, and *e*, and at the fulcrum *c*, of the lever G H, as may be seen by inspecting fig. 1.

Mr. Jordan has also introduced another improvement into the three-way cock, which should not pass without notice, as it may be applied with advantage to other purposes. It is simple, but at the same time very effectual in giving a quick passage to the water. He makes the shell or barrel, and plug of the cock, about 5½ inches long and about 2 inches diameter at one end, and 1½ inch at the other; and instead of cutting out of the plug such a piece as *m*, fig. 3, he removes a long piece *n*, as shewn in fig. 4.

One great advantage that attends the invention is, that where several water-closets may be required in large private buildings, in prisons, hospitals, or extensive manufactories, only one general reservoir is required, nor will the premises ever need to be loaded with any other water than that in the one main reservoir, all the secondary reservoirs being empty whenever the apparatus is not in operation. For the service of any number of water-closets, it is only necessary to connect a pipe for each, with the supply-pipe P, in order to convey water into the secondary reservoir appropriated to each closet respectively; and such is the convenience in fixing this apparatus, resulting from its simplicity, that these pipes, connected with the supply pipe P, may be carried in any direction—as behind skirting boards, up dark corners, or in any other course that may occasion the least cutting of walls or of floors—provided only that the closet be posited at the required depth below the main reservoir. The secondary reservoir is commonly made about 8 inches in diameter, and 2 feet long: the pipe P is common ¾-inch lead pipe, inside diameter; the pipe D about 1½ inch diameter; and the injection pipe N not less in its smallest part. The soil-pipe U is of the usual dimensions, namely, about four inches in diameter.

WATER *Bailiff*, is an officer in sea-port towns, appointed for the searching of ships; and in London the water bailiff has the supervising and search of fish brought thither, and the gathering of the toll arising from the Thames; his office is likewise to arrest men for debt, &c. or other personal or criminal matters upon the river Thames.

WATER *Colours*. The general or simple colours, and the various species of each, fit for painting in water colours, are as follow:

*Whites*: Constant white, white lead, flake white. *Blacks*: ivory black, lamp black. *Greens:* green bice, sap green. *Blues:* indigo, smalt, Prussian blue, ultramarine, ultramarine ashes. *Browns:* umber, burnt umber, bistre, burnt terra de sienna, unburnt ditto. *Reds*: burnt ochre, Indian red, lake, vermilion, carmine, Indian lake. *Yellows:* English ochre, gamboge, orpiment, Roman ochre, Italian pink, king's yellows.

WATER *Course*. A water course does not begin by prescription or assent, but begins *ex jure naturæ*, having this course naturally, and cannot be diverted.

WATER *Borne*, the state of a ship with regard to the water surrounding her bottom, when there is barely a sufficient depth of it to float her off the ground.

WATER *Lines*, horizontal lines, supposed to be drawn about the outside of the ship's bottom, close to the surface of the water on which she floats; they are, accordingly, higher or lower upon the bottom, in proportion to the depth of the column of water required to float her.

WATER-*logged*, the state of a ship, when, by receiving a great quantity of water into her hold, by leaking, &c. she has become heavy and inactive upon the sea, so as to yield without resistance to the efforts of every wave rushing over her decks. In this dangerous situation there is no resource for the crew, except to free her by the pumps, or to abandon her by getting into the boats; for the centre of gravity is no longer fixed, but fluctuating from place to place; the ship entirely loses her stability, and is almost totally deprived of the use of her sails, which may only operate to accelerate her destruction by oversetting her, or pressing the head under water.

**Water** *Mill*. *See* Mechanics.

**Water** *Sail*, a small sail spread occasionally under the lower studding sail or driver boom, in a fair wind and smooth sea.

**Water** *Spout*. *See* Spout.

**Water** *Ways*, long pieces of timber serving to connect the sides of a ship to her decks, and form a channel to carry off the water from the latter by means of scuppers.

**Water** *Works*, in general, denote all manner of machines, moved by, or employed in raising or sustaining water; in which sense water-mills of all kinds, sluices, aqueducts, &c. may be called water-works.

**Water** *Wheel*, the wheel of a water-mill, on which the water acts as a first mover.

**WATERING Place**, in a nautical sense, is a situation where boats can load fresh water for the use of a ship. There is nothing contributes more to the health of seamen than plenty of fresh water. This is an observation made by the great Captain Cook, who is entitled to perpetual remembrance, not more for his nautical talents and the large additions which he has made to the stock of geographical knowledge, than for the humanity which he displayed on all occasions; but in no instance so conspicuously as in his unwearied attentions to the preservation of the health of seamen. It is, therefore, an object of no small importance to discover how water may be prevented from becoming putrid, or be corrected and restored after it has become putrid, during long voyages. Accordingly, the Society for the Encouragement of Arts, &c. deemed this a proper subject for one of the prize questions.

It appears, from some late experiments, that foul water may be rendered sweet and pure by means of charcoal powder and quicklime. The following observations on this subject are extracted from a number of Crell's Chemical Journal, English translation:—"The correction or restoration of putrid water by means of charcoal is so easy, so simple, and so cheap a process, that it deserves to be preferred to all other methods hitherto proposed. In all experiments that have been made, it has been found that charcoal powder, added in greater or less proportion, according to the degree of putrefaction and the quantity of putrid particles, renders foul water sweet by agitation therewith for a few minutes. The subsequent separation of the charcoal from the water is effected with little difficulty. The employment of quicklime, in conjunction with charcoal, is found to contribute considerably to the purification of foul water, especially if the water abound with extractive matter, which the quicklime precipitates, and thereby fines the water, and renders it perfectly clear. But the bad smell of the water cannot be taken off by lime alone. The purifying operation of quicklime in conjunction with charcoal is most striking in the case of water in which flax has been suffered to putrefy; such water has an highly offensive smell. That which was used in these experiments was as black as ink; by addition of quicklime it was soon rendered quite clear and limpid, the lime carrying down with it black flakes to the bottom of the vessel; but the bad smell, instead of being removed, was made worse, and could only be got rid of by the addition of the charcoal powder. Water in which cabbage has been steeped, and which was of a yellowish brown colour, was in like manner rendered fine and clear by quicklime, but did not part with its stinking smell till charcoal was mixed with it.

"For the separation of the portion of lime which, in this mode of purification, remains dissolved in the water, it is proposed to employ, (in preference to fixed air) either acid of tartar or vitriolic acid. Water that has undergone putrefaction is deprived of its fresh and brisk taste, which charcoal is not capable of restoring; hence the water that has been thus purified tastes soft and vapid. For the restoration of its pleasant refreshing taste, fixed air is recommended to be mixed with it. The disagreeable mouldy taste which some waters have in their natural state may be corrected by simple filtration through charcoal powder; which has this farther advantage, that it separates at the same time all extraneous matter that is mechanically mixed with the water, and thereby renders it pure and clear. Water that has been kept mixed with charcoal for a whole year was not perceived to have the least putrid smell. Hence it is proposed to make trial of charcoal in sea voyages. It is farther proposed to correct, by the same means, the bilge water which so much contaminates the whole air in ships."

**WATERMEN.** In London, the lord mayor and court of aldermen have great power in governing the company of watermen, and appointing the fares for plying on the river Thames; and justices for Middlesex, and other adjoining counties, have also power to hear and determine offences, &c. See 10 G. II. c. 31.

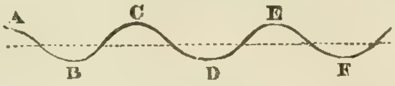
**WATT, James, Esq. F. R. S.**, born in Greenock, in the year 1736, was educated in the public schools of his native town; his partiality for the scientific arts soon developed itself, and at the age of eighteen he went to London, and placed himself under the tuition of an eminent mathematical instrument-maker, but ill-health occasioned his return to Greenock in about a year; and this appears to be the only instruction he ever received,—all the rest was self-acquired: but so early had his talents developed themselves, that in 1757, when he was in his 21st year, he was appointed mathematical instrument-maker to the university of Glasgow, with apartments in the college. From these he removed to the city of Glasgow, in 1764, and in that and the subsequent year he invented his improvements on the steam-engine; but circumstances delayed his taking out a patent until the year 1769. From the time of this invention, until the year 1774, he followed the profession of a civil engineer, at Glasgow, and made many surveys of canals and harbours; several of the former of which have been carried into execution. The fortunate circumstance of his undertaking the repairs of a model of a steam-engine, in itself of so little importance, led to one of the greatest revolutions in mechanics that has taken place by any one invention since the records of history. *See* Steam Engine.

A gentleman of some property and considerable knowledge, Dr. Roebuck, who was capable of appreciating the merit both of the inventor and of the invention, at last united himself with Mr. Watt, in the enterprise of bringing the matter to perfection: but his means were unequal to the purpose; and after expending all he could afford, the affair was on the point of being abandoned, when Mr. Boulton the great Birmingham manufacturer, heard of the invention. Few men were more capable than Matthew Boulton of appreciating the value of Mr. Watt's discovery, and none more disposed to engage in a liberal manner in the enterprise. To a generous and an ardent mind, Mr. Boulton added an uncommon spirit for undertaking what was great and difficult. Perhaps if Mr. Watt had searched all Europe, he could not have found another person so fitted in every way to assist in bringing the invention to bear. Mr. Boulton had money at command; he was a man of address and influence, and advantageously known to the world: in short, he was just the person who was wanted; and after reimbursing Dr. Roebuck for his expenditure and loss, he became partner with Mr. Watt, who removed to Birmingham. In 1779, while Mr. Watt's grand invention of the steam-engine was gradually improving, he contrived the machine for copying letters by means of a thin moist paper and two rollers. It is a minor invention, though very useful, and one by which, to use his own words, time, labour, and money are saved; despatch and accuracy are attained; and secrecy is preserved. It has got into general use all over the world, and gives Mr. Watt another claim to the gratitude of mankind. The life of a sedentary or studious man produces few incidents; but in particular, when, like Mr. Watt, he happens not to live amongst a society where he can associate much with others of a similar cast. Birmingham, or the country round, afforded few men who were calculated to associate with Mr. Watt; accordingly he was almost constantly at home, and very seldom in company. He had for a number of years quitted business, having acquired an independence, and having a son to continue the manufactory, with the son of Mr. Boulton. Mr. Watt was a Fellow of the Royal Society of London, and a member of the Institute of Paris; and there is not any body of learned or scientific men in Europe, that would not have thought his being admitted into their number an honour conferred upon them. He died at the age of eighty-four, at his house at Heathfield near Birmingham, having enjoyed his usual health and spirits almost to the last.

WAVE, in Physics, a volume of water elevated by the action of the wind, &c. upon its surface, into a state of fluctuation, and accompanied by a cavity. The extent from the bottom, or lowest point of one cavity, and across the elevation, to the bottom of the next cavity, is the breadth of the wave. Waves are considered as of two kinds, which may be distinguished from one another by the names of natural and accidental waves. The natural waves are those which are regularly proportioned in size to the strength of the wind which produces them. The accidental waves are those occasioned by the winds reacting upon itself by repercussion from hills or high shores, and by the dashing of the waves themselves, otherwise of the natural kind, against rocks and shoals; by which means those waves acquire an elevation much above what they can have in their natural state.

*Motion of the Waves.*—This makes an article in the Newtonian philosophy, that author having explained their motions, and calculated their velocity from mathematical principles, similar to the motion of a pendulum, and to the reciprocation of water in the two legs of a bent and inverted syphon or tube. His propositions concerning such canal, or tube, is the forty-fourth of the second book of his Principia, and is this: "If water ascend and descend alternately in the erected legs of a canal or pipe; and a pendulum be constructed whose length, between the point of suspension and the centre of oscillation, is equal to half the length of the water in the canal; then the water will ascend and descend in the same time in which the pendulum oscillates." The author hence infers, in prop. 45, that the velocity of waves is in the subduplicate ratio of their breadths; and in prop. 46, he proceeds to find the velocity of waves, as follows: "Let a pendulum be constructed whose length between the point of suspension and the centre of oscillation is equal to the breadth of the waves, and in the time that the pendulum will perform one single oscillation the waves will advance forward nearly a space equal to their breadth. That which is called the breadth of the waves being the transverse measure lying between the deepest part of the hollows, or between the tops of the ridges."

Let A B C D E F represent a stagnant water ascending and descending in successive waves. Also let A, C, E, &c. be the tops of ths waves; and B, D, F, &c. the intermediate hollows. Because the motion of the waves is carried on by the successive ascent and descent of the water; so that the parts of it, as A, C, E, &c. which are highest at one time, become lowest immediately after, and because the motive force, by which the highest parts descend and the lowest ascend, is the weight of the elevated water, that alternate ascent and descent will be analogous to the reciprocal motion of the water in the canal, and observe the same laws as to the times of its ascent and descent, and therefore, (by prop. 44, above mentioned,) if the distances between the highest places of the waves A, C, E, and the lowest B, D, E, be equal to twice the length of any pendulum, the highest parts, A, C, E, will become the lowest in the time of one oscillation, and in the time of another oscillation will ascend again. Therefore between the passage of each wave, the time of two oscillations will intervene; that is, the wave will describe its breadth in the time that the pendulum will oscillate twice; but a pendulum of four times that length, and which therefore is equal to the breadth of the waves, will just oscillate once in that time, Q. E. I.



*Corol.* 1. Therefore waves, whose breadth is equal to 39⅛ inches, or 3$\frac{25}{96}$ feet, will advance through a space equal to their breadth in one second of time; and therefore in one minute they will go over a space of of 195⅝ feet; and in an hour a space of 11737 feet nearly, or two miles and almost a quarter.

*Corol.* 2. And the velocity of greater or less waves will be augmented or diminished in the subduplicate ratio of their breadth.

But waves never emerge and sink again in the same place. They seem to take their origin from some agitated spot, and appear thence to advance in expanding concentric circles. The subaqueous propulsion accompanying them decides no doubt the direction of their progress, and prevents them from remaining in a pendulous state. If we examine attentively the motion of a wave, we shall find that the fore-part is always in the act of rising, while the hinder part is constantly sinking. The whole system hence appears to roll onwards, though there is actually no translocation of any portion of the mass, and each particle in succession merely oscillates with nearly a vertical ascent and descent. The motions of waves are perfectly imitated on the stage, by turning slowly an open helical screw applied round an horizontal axis. This effect is produced by the varying rate of the vertical elevation and depression, which must be as the versed sine of the distance of each point from the summit. Its celerity is greatest in emerging from the level of the water; it becomes stationary when it has gained its utmost ascent; but it again acquires an equal and opposite celerity as it sinks under that level, till it comes to pause at the limit of depression. The figure and apparent motion of a wave hence result from this unequal and reciprocating vertical play of each particle, combined with the continued and uniform advance of the inciting energy.

WAX. The upper surface of the leaves of many trees is covered with a varnish which may be separated and obtained in a state of purity, and found to possess all the properties of bees-wax; hence it is justly inferred that wax is a vegetable product, and that the bees extract it unaltered from the leaves of trees and other vegetable substances that contain it. Several plants contain wax in such abundance as to make it worth while to extract it from them.

WAY, a road or passage. A way may be by prescription, as if the owner and occupiers of such a farm have immemorially used to cross another's ground; for this immemorial usage supplies an original grant. A right of way may also arise by act and operation of law; for if a man grants to another a piece of ground in the middle of his field, he at the same time tacitly gives him a way to come at it, for where the law gives any thing to any person, it gives by implication whatever is necessary for enjoying the same.

WAY OF A SHIP, the course or progress which she makes on the water when under sail. Thus, when she begins her motion, she is said to be under way; and when that motion increases, she is said to have fresh way through the water. Hence also, she is said to have head way, or stern way, to gather way, or to lose way, &c.

WAYGHTES, or WAITS. This noun formerly signified hautboys; and which is remarkable, has no singular number. From the instruments, its signification was, after a time, transferred to the performers themselves; who being in the habit of parading the streets by night with their music, occasioned the name to be applied generally to all musicians who followed a similar practice. Hence those persons who annually, at the approach of Christmas, salute us with their nocturnal concerts, were and are to this day called wayghtes.

WEATHER, the state of the atmosphere with regard to the degree of wind, to heat or cold, or to dryness and moisture, but particularly to the first. Mr. Kirwan, in vol. v. of the Transactions of the Irish Academy, has laid down the following rules, as the result of a careful examination of observations which had been made in England, during a period of 112 years.

1. When no storm has either preceded or followed the vernal equinox, the succeeding summer is generally dry, or at least so, five times out of six.

2. If a storm happen from an easterly point, on the 19th, 20th, or 21st day of May, the ensuing summer will, four times in five, be also dry. The same event generally takes place, if a storm arise on the 25th, 26th, or 27th days of March, in any point of the compass.

3. Should there be a storm, either at south-west or at west-south-west, on the 19th, 20th, 21st, or 22d of March, the following summer is wet, five times out of six.

In England, if the winters and springs be dry, they are generally warm: on the contrary, dry summers and autumns are usually hot; as moist summers are cold. Thus, if the humidity or dryness of a particular season be determined, a tolerably correct idea may be formed respecting its temperature. To these indications may be added the following maxims; which, being the result of observations made by accurate inquirers, may so far be depended upon, as they will afford a criterion of the mildness or severity, and of the dryness or moisture, of future seasons.

1. A moist autumn, succeeded by a mild winter, is generally followed by a dry and cold spring; in consequence of which, vegetation is greatly retarded.

2. Should the summer be uncommonly wet, the succeeding winter will be very severe; because the heat or warmth of the earth will be carried off by such unusual evaporation. Farther, wet summers are mostly attended with an increased quantity of fruit on the white-thorn and dog-rose; nay, the uncommon fruitfulness of these shrubs is considered as the presage of an intensely cold winter.

3. A severe winter is always indicated by the appearance of cranes and other birds of passage at an early period in autumn; because they never migrate southwards, till the cold season has commenced in the northern regions.

4. If frequent showers fall in the month of September, it seldom rains in May; and the reverse.

5. On the other hand, when the wind often blows from the south-west, during either summer or autumn; when the air is unusually cold for those seasons, both to our sensations, and by the thermometer; at the same time, the mercury being low in the barometer;—under these conditions, a profuse fall of rain may be expected.

6. Great storms, rains, or other violent commotions of the clouds, produce a kind of crisis in the atmosphere; so that they are attended with a regular succession, either of fine or of bad weather, for some months.

Lastly, an unproductive year mostly succeeds a rainy winter; as a rough and cold autumn prognosticates a severe winter. See also the article BAROMETER.

**WEATHER** is also applied to every thing lying to windward of a particular situation: hence a ship is said to have the weather-gage of another, when she is further to windward. Thus also, when a ship under sail presents either of her sides to the wind, it is then called the weather-side, and all the rigging, &c. situated thereon are distinguished by the same epithet, as, the weather shrouds, weather lifts, weather braces, weather bow, weather quarter, &c.

*Table of the Weather, from Dr. Herschell's Observations.*—The following table is from observations taken by the late Dr. Herschell, concerning the weather.

| Time of New or Full Moon, or of entering the First Quarter. | | Weather likely to follow during the Quarter. | |
|---|---|---|---|
| | | In Summer. | In Winter. |
| 12 Noon, to | 2 P.M. | Very Rainy,........ | Snow or Rain. |
| 2 P.M. to | 4 — | Changeable,........ | Fair and Mild. |
| 4 — to | 6 — | Fair,.............. | Fair. |
| 6 — to | 10 — | Fair, if Wind N.W...<br>Rain, if Wind S or S.W | Fair, Frosty if Wind N. or N.E.<br>Rain or Snow, if Wind S. or S.W. |
| 10 — to | 12 Midnight, | Fair,.............. | Fair and Frosty. |
| 12 Midnight, to | 2 A.M. | Fair,.............. | Hard Frost unless Wind S. or W. |
| 2 A.M. to | 4 — | Cold, with Showers,.. | Snow and Stormy. |
| 4 — to | 6 — | Rain,.............. | Snow and Stormy |
| 6 — to | 8 — | Wind and Rain,..... | Stormy. |
| 8 — to | 10 — | Changeable,........ | Cold, Rain if wind W., Snow if E. |
| 10 — to | 12 Noon, | Frequent Showers, .. | Cold, with high Winds. |

**WEATHER** *Beaten*, an epithet applied to any thing which appears to have borne much hard or rough weather.

**WEATHER** *Bit*, a turn of the cable about the end of the windlass, outside of the knight-heads. It is used to check the cable, in order to slacken it gradually in tempestuous weather, or when the ship rides in a strong current.

**WEATHER** *Boards*, are pieces of plank placed in windows of a dwelling, or in the ports of a ship, when laid up in ordinary; they are in an inclined position, so as to turn off the rain without preventing the circulation of air.

*Composition for Preserving Weather Boarding.*—Take three parts of air-slacked lime, two of wood ashes, and one of fine sand, or sea-coal ashes. Sift these through a fine sieve, and add as much linseed oil as will bring it to a consistence for working with a painter's brush; great care must be taken to mix it perfectly. Two coats are necessary, the first rather thin, the second as thick as can conveniently be worked.

**WEATHER** *Cloths*, long pieces of canvass or tarpauling, used to preserve the hammocks from injury by weather when stowed; also to defend persons from the wind and spray.

**WEATHER** *Helm*, a ship is said to carry a weather helm when she is inclined to come too near the wind, and therefore requires the helm to be kept constantly a little to windward.

**WEATHER** *Rolls*, those inclinations which a ship makes to windward in a heavy sea; those which she makes to leeward being termed lee-lurches.

**WEATHER** *Glass.* *See* BAROMETER and HYGROMETER

**WEATHER** *Shore*, the shore which lies to windward of a ship.

**WEATHER** *Tide*, implies that which, by setting against a ship's lee-side, while under sail, forces her up to windward.

**WEATHER-GLASSES**, are instruments contrived to indicate the state or disposition of the atmosphere, and the various alterations in the weather: such are barometers, thermometers, hygrometers, &c.

**WEAVERS.** The wages of journeymen weavers in London are to be settled by the lord mayor, recorder, and aldermen. Masters giving more wages than is appointed, to forfeit 50l. and journeymen demanding, or combining to demand more, to forfeit 40s. or be imprisoned three months.

**WEAVING.** With the antiquity of weaving we are neither much acquainted, nor, however amusing such knowledge might be to the antiquarian, is this loss greatly to be regretted. That the art was brought to considerable perfection in very early ages, is sufficiently obvious both from sacred and profane history. There seems also little doubt that it is of Asiatic origin, and has only gradually extended to the western parts of Europe. We have the authority of Julius Cæsar, that, when he invaded Britain, it was totally unknown; and the many public acts relative to the woollen manufacture in the earlier period of English history, evidently prove that the greater part of our wool was, for a long series of years, exported in a raw state, and manufactured upon the continent. The cruelties and atrocities of the Duke of Alva, in 1567, and the subsequent persecutions attendant on the revocation of the edict of Nantz by Louis XIV. are assigned by historians as the causes which gave to Britain the knowledge and ingenuity of foreign artisans, and permanently founded the woollen and linen manufactures, the former of which has become the acknowledged staple of England, and the latter of Ireland. The much more recent invention of Sir Richard Arkwright has introduced the very extensive manufacture of cotton, and added a lucrative and elegant branch of traffic, the lighter and fanciful department of which has become, in some measure, the staple manufacture of Scotland; whilst the more substantial and durable have added to England a manufacture, inferior, in importance and extent, only to the woollen.

The process of manufacture of all these descriptions of cloth, from the raw to the finished or marketable state, may be divided into three great stages of manufacture.

1st. The preparatory processes which the raw material undergoes, to bring it into that state in which it is fit to assume the appearance of cloth, or what is generally understood by the term *yarn*. For the account of these operations, we must refer the reader to the respective articles COTTON, FLAX, WOOL, SILK, LOOM, &c.

2d. The operations by which the materials are brought from the state of yarn into of that of cloth, which is properly the subject of this article, but which we can here only treat in a general way; for the different kinds are so numerous and varied, that we must refer much of the peculiarities to the articles which will be found under the respective titles or names by which various kinds of cloths or stuffs are known.

3d. The processes which the cloth undergoes, after coming out of the weaver's hands, to fit it for the market, and which we must also refer to the various articles—BLEACHING, DYEING, PRINTING, CALENDERING, GLAZING, and many others.

In general, we may remark, that the great requisites in every species of cloth, from the heaviest to the lightest fabrics, are durability, warmth, and beauty. For those kinds which compose the household furniture and dress of the generality of mankind, the first and second are the most essential; and for the ornamental kinds, which furnish show and splendour to the drapery of the opulent and luxurious, the latter is almost the only quality ever required.

Kendall's loom, which works exactly like the common Spitalfield's loom, with the same tyings, hangings, &c. has its principal action simply promoted by a single revolving bar mounted upon the top of the ordinary loom, equipped with four wipers, and two cams or snails. The two central wipers operating upon a lever, moving the batton as required; the two cams, right and left, acting alternately on a lever each, at the reverse end of which are connected two vertical rods, suspended from a bracket in front of the loom; also the two levers being connected by a spiral spring, that the action of the cams at the necessary periods causes the spring to become charged, as the lever in traversing the cam meets with a sudden declension or fall, causing the spring to operate and drive the shuttle across the work. The other two wipers act upon two treadles, to make the shed or opening for the passage of the shuttle. One revolution of this bar completes two shutes, causes these cams and wipers to act uniformly with each other, performing the whole operation required in simple weaving. The way to accomplish more complex weaving, when more than two treadles are required, is by introducing a second bar, equipped with as many wipers as treadles wanted, the wipers being placed at equal distances on the circle of the bar. If four is necessary, as the principal bar making one revolution acts upon the battons twice; therefore, in order to work over the four treadles upon the second bar, the principal bar in this case must revolve twice to the secondary one, and so on to any given number of treadles. If five treadles are required, the principal bar must revolve two and a half times to the secondary bar once, and so on to any other number, the two bars being regulated by equipping each with cog-wheels for that purpose. If a greater number of treadles are required more than this, or the hand-loom is able to accomplish with ease, it only requires the aid of the jackard mounted upon the loom, simplifying the complex figured weaving. This loom is effective and simple: a boy of 12 years of age, with a proper fly-wheel, would find no difficulty in turning six or eight of these looms. The number of looms one weaver is capable of working must depend on two principal objects,—the quality of the goods manufactured, and the quality of the material made use of, varying from two to five looms, such as persians, sarcenets, levantines, and poor satins, which, with good materials, require little attention. Rich works, with an able weaver and good materials, will be able to work two looms with an addition of some light work before mentioned. The work is, of course, better than that performed according to the old plan by hand; the machine acting more steadily, and operating with less of stickings.

Previous to entering into any details of other particulars, we shall lay before our readers such general remarks as occur upon what is termed the fabric of cloth, a matter which we conceive to be not only of the most essential importance, but which has been most unaccountably neglected, even by those who practise the manufacture, and who, with very few exceptions, regulate their operations in this respect by no fixed or determinate rule, but generally are contented merely to copy what they are taught, without any other guide to detect error than natural experience, which very frequently is dearly purchased. Yet we conceive it very possible, that this important point may be reduced to such a degree of mathematical precision, as might render it capable of conclusive demonstration, or at least that the approximation may be so near, as to guard the person who will be at pains to adopt it, from almost the slightest danger of great error, even in regulating the fabric of any species of cloth to which he has not been previously accustomed. For the better understanding of this method, it may be necessary to consider, very briefly, that quality of yarn which is called its *grist* or *fineness*.

If a thread of yarn be considered as a cylinder, its weight must be in the compound ratio of its magnitude and density. Now, yarn being made up in hanks of a determinate length, this length may be considered as the altitude of the cylinder. If cylinders are in proportion to their circumscribing squares, the square root of the square will be equal to the diameter of the base. When yarn of any kind is warped, and stretched in a loom, to undergo the subsequent operation of being woven into cloth, the threads which compose the warp are parallel to each other, and their parallel situation is preserved by the utensil called the reed, through the intervals between the divisions of which a certain number of threads pass. The number of divisions in this reed, therefore, ascertains the number of threads of a warp which are to be woven into cloth of any determinate breadth. Now the breadth of every thread or cylinder being the diameter of its base, and the reed being the scale which regulates the number of these threads in a given measure, the ratio which the one bears to the other ascertains the number of threads, and their contiguity to each other in the cloth. Let then the square root of the mass in any determinate length of yarn be taken as the measure of the diameter of the base of a thread, and let the number of the reed which will form a proper fabric, be known, and any other will be found to form a similar fabric. From this arises a very simple analogy or proportion, which may be thus stated:—Let the weight of one kind of yarn be expressed by $a$, and that of another by $b$. Let $a$ be properly woven in a reed or scale which contains 1200 intervals or divisions in 37 inches, which is the common measure of the linen reed. Then to ascertain the proper reed for $b$, the proportion will be as $\sqrt{a}$ is to 1200, so is $\sqrt{b}$ to the reed required. Hence, as $a$ is to 144, so is $b$ to the square of the reed required. Suppose now, that $a$ represents cotton yarn No. 60, and $b$ represents No. 100, then,

$$60 : 144 :: 100 : 14{,}400,$$

the root being 15·49 nearly, which is the answer. From this the following simple arithmetical proportion will arise for practical use.

1st. If the yarn is known, and the number of the reed wanted,
As the name or designation of the first yarn given
To the square of the given reed,
So is the name or designation of the second yarn
To the square of the reed required.

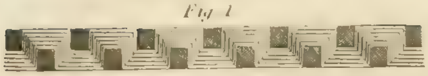
2d. If, as before, the yarn and reed are known, and the yarn wanted to fit any other reed.
As the square of the given reed,
To the yarn,
So is the square of the other reed
To the yarn required.

In actual practice, the following objection, which is very plausible, will readily occur to practical manufacturers, and, at first sight, will probably induce almost the whole of them to reject these rules as erroneous and inconclusive. They will assert, and with truth, that a manufacturer who would implicitly adopt and follow these rules, would either make all his fine goods so dense and heavy in the fabric as to disgust his customers; or that his coarse goods would be so flimsy in the texture as to be totally useless. To this it is only necessary to reply, that it arises from no error in the calculation, nor want of truth in the general principle, but in what was premised as a general requisite in cloth at the outset, namely, that the durability and thickness is the first object in coarse goods, and beauty and transparency in fine. It would afford but a slender recommendation to a birth-day dress, to possess that warmth and durability which would form the chief excellence of a watch-coat or blanket; and it would be equally useless to give to the coarse manufacture, which is valuable in proportion to the shelter which it affords from the inclemency of wind and weather, qualities which could only afford gratification to the eye, by the sacrifice of every comfort.

The warp of a web being longitudinally stretched in parallel straight lines, and the warp or weft being inserted at right angles to it, the substance produced as cloth will bear a strong analogy to the form of a raft of wood, consisting of two platforms of square beams laid across each other, and fastened together; or if we suppose, that a number of cylindrical pieces of wood, such as the top masts or yards of a ship, are laid parallel to each other, and that cords or ropes are interwoven between them together, we shall have a very exact representa-

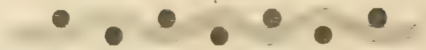
PRINCIPLE OF TEXTURE.

*Fig 1.*



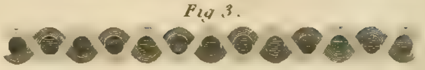
OPEN FABRIC.

*Fig 2.*



CLOSE FABRIC.

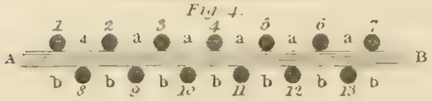
*Fig 3.*



OPEN FABRIC.

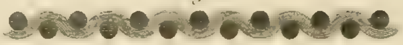
*Direction and Rate of Contraction*

*Fig 4.*



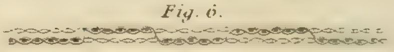
COMMON FABRIC.

*Fig 5.*



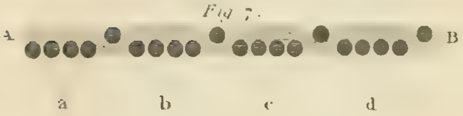
DOUBLE OR CARPET FABRIC.

*Fig. 6.*



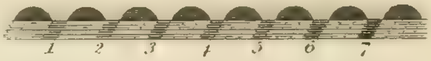
TWEELED FABRIC.

*Fig 7.*



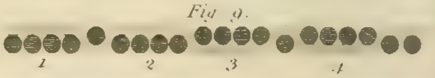
VELVET FABRIC.

*Fig. 8.*



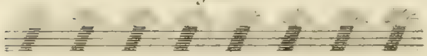
DIMITY, DIAPER KERSEYMERE.

*Fig 9.*



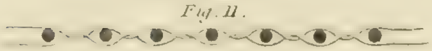
CORD DU ROI.

*Fig. 10.*



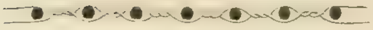
COMMON GAUZE.

*Fig. 11.*



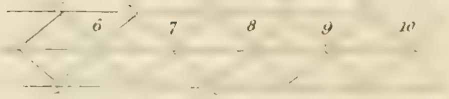
CAT GUT.

*Fig. 12.*



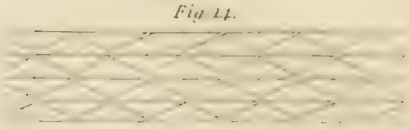
WHIP NET.

*Fig. 13.*



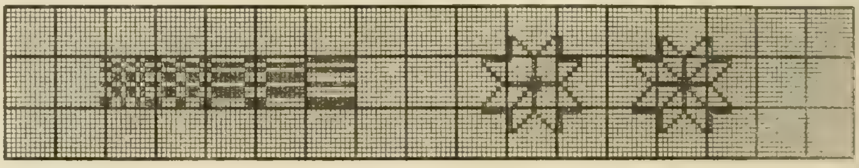
MAIL NET.

*Fig 14.*



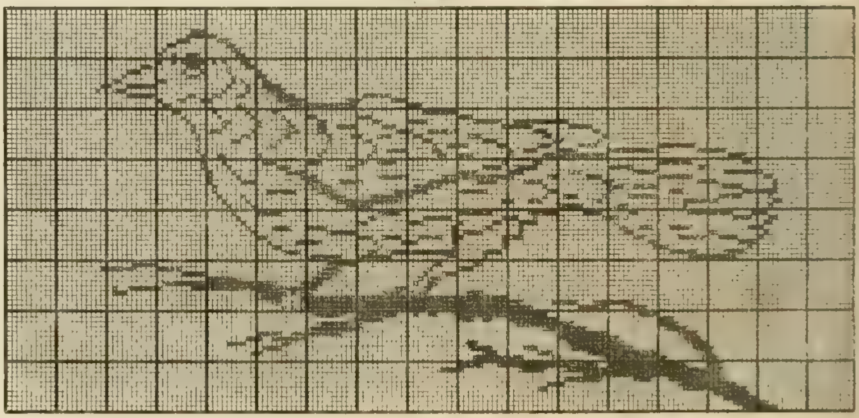
DORNOCK & DIAPER.

*Fig 15.*



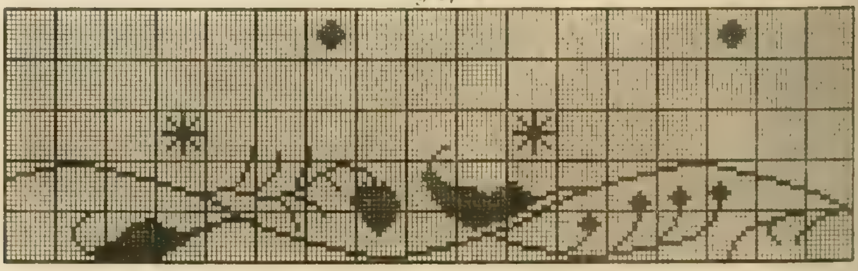
DAMASK & TAPESTRY.

*Fig 16.*



BORDERS, STRIPES & SPOTTING.

*Fig 17.*



tion of a piece of cloth on a scale of such magnitude as will admit of all the proof of actual measurement. In cloth, even of the finest kinds, the length, breadth, and number of the component thread of cylinders, in the piece, may be ascertained with equal precision; but from the smallness of the diameter of every thread, it becomes impossible to measure them actually with any degree of accuracy. The length and the weight, or mass, however, being known, the diameter may be found by a calculation, which bears evident marks of great exactness, and we may then safely assume that no difference can arise, provided the densities of all threads are the same. Upon this point, however, there has been some difference of opinion, and the subject has been so little investigated in a scientific manner, that it would be perhaps presumptuous to draw any absolute conclusion upon it. We shall therefore only observe, that the argument upon which the increase of density in fine yarn above coarse chiefly rests, is this, that in spinning fine yarn, a greater number of revolutions of the wheel are necessary to give the twist sufficiently to produce a proper cohesion of the fibres than in coarse. This is incontrovertibly true; and as the filaments or fibres, by this twisting, assume the form of a screw or spiral, the point to be decided is, simply, whether by this excess of twisting, the fibres of fine yarn are not brought more closely into contact than those of coarse; and consequently, that the diameter of the thread is diminished in the same proportion that the twisting is increased.

It must be obvious, that where the circumference exposes a small surface, many more revolutions will be required than where it presents a large one, before all the fibres can be sufficiently stretched; and consequently, that fine yarn will always require more twisting than coarse, to give it the same tenacity. But as every thread, from the stoutest cable to the finest which human art and industry can produce, contracts in length by the operation of twisting, there seems reason enough to conclude, that the compressing power exerted, acts either entirely upon the length, or that what is exerted on the diameter, must bear a very small proportion indeed to the other; we may therefore infer, that the nearest approximation to actual truth, will be to consider a rope or thread like any other solid cylinder, and that the difference of density will not very materially affect the calculation. Upon this principle, we shall easily arrive at a very considerable degree of mathematical precision, and, upon the whole, come nearer to actual truth than by any other hypothesis yet known.

In the Plate (Cloth Manufacture) will be found some figures, explanatory of what further remarks may be necessary on this subject, as connected with the fabric; and it will also be useful in conveying correct ideas of the varieties of texture most generally used both in the substantial and flimsy descriptions of woven goods.

*Principle of Texture.*—Figure 1. This figure may be supposed to represent any solid body composed of various parts, lashed together. If the darkened squares are so many parallel beams of wood, connected by cordage, we arrive at once at a precise idea of texture. The length of these beams is known by measurement: the breadth of the whole consists of the aggregate number of pieces of wood, added to the space which the cords occupy between each, and which will be more or less in proportion to the thickness or diameter of these cords. It is also obvious, that it is impossible to bring the beams into actual contact; for were we to suppose, that the connecting or lashing cords were actually as fine as human hairs, they must still occupy some portion of space. The thickness, it is equally apparent, is that of one beam and one cord; but if we suppose the cords every where in actual contact, we may then also suppose that the thickness is that of the beam and two cords. Now, it is hardly possible to conceive, that in a flexible substance, such as those used in the fabrication of cloth, any means could be devised to bring every thread of woof into actual contact, so as to cover the warp both above and below. We may therefore very safely assume, as a general principle, that the geometrical thickness of cloth is the measure of the diameter of one thread of the warp, added to the measure of the diameter of one thread of the woof; and that when those measures are equal, the thickness of the cloth is, of course, double the diameter of one of the threads of which it is composed. Thus we have the utmost thickness of fabric of which cloth is capable, and more than even the strongest canvass, with which we are acquainted, can possess. Indeed a fabric of this kind, were it even easily attainable, would be practically useless; for the immense increase of density would so completely take away every degree of pliancy and flexibility, that the fabric would be as unsuitable for any purpose to which cloth is properly applicable, as a fir plank or a sheet of copper.

*Open Fabric.*—Figure 2. This figure represents a section of cloth of an open fabric, when the round dots, which represent the warp, are placed at a considerable distance from each other. In this figure we see very evidently, that the geometrical thickness of cloth may be considered in the duplicate ratio of the one thread; for if we suppose the two parallel lines which bound the figure, to represent two boards used in the calender press, where the cloth is finished, and that they are to be pressed together by any mechanical power, we shall at once see that their effect must immediately flatten the threads, and divest them of their cylindrical form.

*Close Fabric.*—Figure 3. This figure represents a plain fabric of that description which approaches the most nearly to any idea we can form of the most dense or close contact of which yarn can be made susceptible. Here the warp is supposed to be so lightly stretched in the loom, as to retain entirely the parallel state without any curves or flexure whatever, and the whole therefore is necessarily given to the woof. This mode of weaving can never really exist; but if the warp be sufficiently strong to bear any light stretching, and the woof be spun very soft and flexible, something very near it may be produced. This way of making cloth is well fitted for those goods which require to give considerable warmth, but they are sometimes the means of very gross fraud and imposition; for if the warp is made of very slender threads, and the woof of slackly twisted cotton or woollen yarn, where the fibrils of the stuff being but slightly brought into contact, are rough and oozy, a great appearance of thickness and strength may be given to the eye, when the cloth is absolutely so flimsy, that it may be torn asunder as easily as a sheet of writing paper. Many frauds of this kind are practised. A very common one is in a kind of fanciful stuff, which used to be hawked about the streets of London, and most of the large towns of Britain, especially the sea ports, by a set of men habited like sailors. These stuffs were composed of very fine silk warp, and very slackly twisted cotton woof, perhaps eight or ten times coarser than the warp. The silk, of course, entirely disappeared, and the semblance of a very strong fabric of cotton was presented, and sold apparently cheap, under the pretence of being smuggled home in an East Indiaman. Strength, beauty, and cheapness, were thus apparently united, and the unwary purchaser, whilst enjoying the triple pleasure of having profitably expended his money, procured a desirable acquisition, and outwitted all the precautions which either the government or directors could take, found, to his infinite astonishment and vexation, upon the first application of the finger and thumb, that his purchase, which was generally extolled by the vender for being as tough as the mainsail of a seventy-four, proved as weak as a cobweb. The impostor generally added to the fraud, by pulling the cloth apparently with great force in that direction in which the coarse woof gave the resistance, but cautiously avoided even a touch against the warp, which would at once have detected the fraud.

*Open Fabric.*—Figure 4. This figure gives a representation of the position of a fabric of cloth in section, as it is in the loom before the warp has been closed upon the woof, which still appears as a straight line. This figure may usefully illustrate the direction and ratio of contraction which must unavoidably take place in every kind of cloth, in a greater or smaller degree, according to the density of the texture, the dimensions of the threads, and the description of the cloth. Let A B represent one thread of woof completely stretched by the velocity of the shuttle in passing between the threads of warp which are represented by the round dots 1, 2, 3, 4, 5, &c. and those distinguished by 8, 9, 10, &c. When these threads are closed by the operation of the heddles to form the intertexture, the first tendency will be to move in the direction 1*b*, 2*b*, &c. for those above, and in that of 8*a*, 9*a*, &c. for those below; but the contraction of A B, by its deviation from a straight to a curved line, in consequence of the compression of the warp thread 1 *b*, 2 *b*, &c. and 1 *a*, 2 *a*, &c. in closing, will produce, by the action of the two powers at right angles to each other, the oblique or diagonal direction denoted by the lines 1, 8—2, 9 to the right, for the threads above; and that expressed by the lines 2, 8—3, 9, &c. to the left, for the threads below. Now, as the whole deviation is produced by the flexure of the thread A B, if A is supposed to be placed at the middle of the cloth, equidistant from the two extremities, or *selvages* as they are called by weavers, the thread at 1 may be supposed to move really in the direction 1 *b*, and all the others to approach to it in the direction represented, while those to the left would approach in the same ratio, but the line of approximation would be inverted. By pursuing this plan, which, as far the writer of this article knows, is totally new, the theory of fabric might be reduced to a very great degree of certainty; and here a field is entirely open for the researches of an expert geometrician to apply the principles of his science to the most extensive and useful manufacture, not only of this country, but of every other.

Figure 5 represents that common fabric used for lawns, muslins, and the middle kind of goods, the excellence of which neither consists in the greatest strength, nor in the greatest transparency. It is entirely a medium between fig. 2 and fig. 3. Its principles are in every respect similar to those already noticed.

In the efforts to give great strength and thickness to cloth, it will be obvious, that the common mode of weaving by constant intersection of warp and woof, although it may be perhaps the best which can be devised for the former, presents invincible obstructions to the latter beyond a certain limit. To remedy this, two modes of weaving are in common use, which, while they add to the power of compressing a great quantity of materials in a small compass, possess the additional advantage of affording much facility for adding ornament to the superficies of the fabric. The first of these is double cloth, or two webs woven together, and joined by the operation. This is chiefly used for carpets; and its geometrical principles are entirely the same as that of plain cloth, supposing two webs to be sewed together. A section of the cloth will be found in fig. 6; and what further relates to this part of the subject, in the article CARPET.

Of the simplest kind of twisted fabrics, a section is given in fig. 7: and as this is a most important branch of the cloth manufacture, it may be proper to consider it with some attention. The great and prominent advantage of the twisted fabric in point of texture, arises from the facility with which a very great quantity of materials may be put closely together. In the figures, the warp is represented by the dots in the same straight line as in the plain fabrics; but if we consider the direction and ratio of contraction, upon principles similar to those laid down in the explanation given of fig. 4, we shall readily discover the very different way in which the tweeling fabric is effected.

Thus we see by the figure, when the dotted lines are drawn at *a*, *b*, *c*, *d*, their direction of contraction, instead of being upon every second or alternate thread, the natural tendency would consequently be to bring the whole into the form represented by the lines and dotted circles at *a*, *b*, *c*, *d*. In point then of thickness, from the upper to the under superficies, it is evident that the whole fabric has increased in the ratio of nearly three to one. On the other hand it will appear, that the four threads or cylinders being thus put together in one solid mass, might be supposed only one thread, or like the strands of a rope before it is twisted; but, to remedy this, the thread being shifted every time, the whole forms a body in which much aggregate matter is compressed; but where, being less firmly united, the accession of strength acquired by the accumulation of materials, is partially contracted by the want of equal firmness of junction.

The second quality of the tweeled fabric, *susceptibility of receiving ornament*, arises from its capability of being inverted at pleasure, according to fig. 9. In this figure, we have, as before, four threads, and one alternately intersected; but here the four threads marked 1 and 2, are under the woof, while those marked 3 and 4 are above. As this in no way affects the solidity or strength of the texture, but is merely an auxiliary aid for the addition of ornament, the further discussion of this property will be more appropriately introduced in that part of this article which relates to the ornamental principles of texture.

Figure 8. This figure represents that kind of tweeled work which produces an ornamental effect, and adds even to the strength of a fabric, in so far as accumulation of matter can be considered in that light. The figure represents a piece of velvet cut in section, and of that kind which, being woven upon a tweeled ground, is known by the name of Genoa velvet; a pretty strong presumption, that the origin of this manufacture at least, in Europe, is Italian. That part, however, which produces the ornament, cannot properly be deemed likely to add much to the strength of the fabric, in so far as this is effected by any attempt at divulsion; but when the impulse is by friction, it must contribute very materially to its preservation. Hence, in practical use, velvets of every kind are in great estimation, for three substantial reasons:—

1st. Because, by combining a great quantity of materials in a small compass, they afford great warmth. 2nd. From the great resistance which they oppose to external friction, they are very durable. And, 3rd. Because, from the very nature of the texture, they afford the finest means of rich ornamental decoration. The use of velvet cloths in cold weather, is a sufficient proof of the truth of the first. The manufacture of plush corduroy, and other stuffs, for the dress of those exposed to the accidents of laborious employment, evinces the second; and the ornamented velvets and Wilton carpeting, are demonstrative of the third of these positions..

In the figure, the diagonal form which both the warp and woof of cloth assume, is very apparent, from the smallness of the scale. Besides what this adds to the strength of the cloth, the plushed part, which appears interwoven at the darkly shaded intervals 1, 2, 3, &c. forms, when finished, the whole covering or upper surface. The principle, in so far as regards texture, is entirely the same as any other tweeled fabric, and a more minute discussion must be referred to the particular article.

*Corduroy.*—Figure 10. This figure, which represents corduroy, or king's cord, is merely striped velvet. The principle is entirely the same; and the figure itself will sufficiently evince that the one is merely the copy of the other. The remaining figures in the plate represent those kinds of work which are of the most flimsy and open description of texture; those in which neither strength, warmth, nor durability, is much required, and of which openness and transparency are the chief recommendations. For these reasons, the nature and principle of the texture may be better understood by considering them as mere superficies, than by any section which could be exhibited. The two kinds of gauze and catgut, which form the basis of all the varieties, are still exhibited in section, and the two others, which may be varied almost to infinity, are shewn superficially.

*Common Gauze.*—Figure 11. This figure represents common gauze, or linau, a substance used for various purposes. The essential difference between this description of cloth and all others, consists in the warp being twined or twisted like a rope during the operation of weaving; and hence it bears a considerable analogy to the substance usually known by the name of lace. The twining of gauze is always open, flimsy, and transparent; but, from the twining of the warp, it possesses an uncommon degree of strength and tenacity, in proportion to the quantity of materials which it contains. This quality, together with the transparency of the fabric, renders it peculiarly adapted for ornamental purposes of various kinds, particularly for flowering or figuring, either in the loom, or by the needle.

In the warp of gauze there arises a much greater degree of contraction during the weaving than in any other species of cloth, and this is produced by the twining. The geometrical ratio of this contraction must evidently depend entirely upon the same principle which regulates the contraction of the yarn in spinning, and therefore it is unnecessary to add to what has been already stated upon that subject. By inspecting the figure, it will be apparent, that the twisting between every intersection of woof amounts precisely to one complete revolution of both threads; hence the following difference between this and every other species of weaving, namely, that the same thread of warp is always above the woof, and the contiguous thread is always below.

*Catgut.*—Figure 12. This figure represents a section of another species of twisted cloth, which is known by the name of catgut, and which differs only from the gauze, by being subjected to a greater degree of twine in weaving, for in place of one revolution between each intersection, a revolution and a half is always given; and thus the warp is alternately above and below, as in other kinds of weaving. The ratio of contraction in this, as in the former, is evidently reducible to the same principles which regulate the spinning.

*Whip Net.*—Figure 13. This figure is a superficial representation of the most simple kind of ornamental net-work produced in the loom. It is called a whip-net by weavers, who use the term whip for any substance interwoven in cloth for ornamental purposes, when it is distinct from the ground of the fabric. In this, the difference is merely in the crossing of the warp; for it is very evident, that the crossings at 1, 2, 3, 4, and 5, are of different threads from those at 6, 7, 8, and 9. The contraction in weaving this kind of stuff, is vastly greater than any other, and may very easily be ascertained with the utmost geometrical precision, depending entirely on the well-understood principles of plain trigonometry; for it will hardly be necessary to take into the account what contraction takes place by the crossing of the threads in a fabric so very open and flimsy. Thus, if the diamond is crossed at 1 by a dotted line, four right-angled triangles will be formed, and the contraction of the warp will be in the ratio which the hypothenuse of each bears to the perpendicular; the former being the longitudinal measure of the warp when stretched in the loom, and the latter that of the cloth in its finished state. This reduces the contraction at once to the Pythagorean proposition, that the two are to each other in the ratio of their respective squares.

*Mail Net.*—Figure 14. This figure represents, superficially, what is called the mail-net, and is merely a combination of common gauze and the whip-net in the same fabric; the gauze here being in the same direction as the dotted line in the former figure. The whole fabric is evidently a continued succession of right-angled triangles, of which the woof forms the bases, the gauze part the perpendiculars, and the whip part the hypothenuses; the contraction here being very different, it is necessary that the gauze and whip parts should be stretched upon separate beams.

The above may be regarded rather as hints for the further investigation of the geometrical principles of the cloth manufacture, than as the absolute results of a perfect and matured theory. As nothing has been published upon the subject, the author of this article can only plead its obvious importance, as the motive which has led him to communicate what has occurred to him as likely to promote a more ample and scientific inquiry.

We now proceed to state what occurs upon the ornamental principles of texture, referring the reader to figs. 15, 16, and 17.

In order to produce ornamental figures upon cloths, it is necessary that the apparatus, or mounting of the loom, should be properly arranged for the purpose intended, previously to the commencement of the subsequent operations. The rules for this are pretty similar in all the different kinds of ornamental work, and the plans being previously drawn upon design paper, the first operation is to adapt the loom to the design. The designs, or patterns, are included between a certain number of parallel straight lines drawn upon the paper, and intersected by others drawn at right angles to the first.

The lines which are drawn from the top to the bottom of the paper may be supposed to represent the warp, and those drawn across, the woof of the web; any number of threads being supposed to be included between every two lines. The paper thus forms a double scale, by which, in the first instance, the size and form of the pattern may be determined with great precision; and the whole subsequent operations of the weaver, both in mounting and working his loom, regulated with certainty and accuracy. To enable the projector of a new pattern to judge properly of its effects when transferred from the paper to the cloth, it will be essentially necessary that he should bear constantly in his view the comparative scale of magnitude which the design will bear in each, regulating his ideas always by square or superficial measurement.

Thus in the large design, fig. 16, representing a bird perched upon the branch of a tree, it will be proper, in the first place, to count the number of spaces from the point of the bill to the extremity of the tail; and to render this the more easy, it is to be observed, that every tenth line is drawn considerably bolder than the others. This number in the design is 135 spaces. Counting again from the stem of the branch to the upper part of the bird's head, he will find 76 spaces. Between these spaces, therefore, the whole superficial measure of the pattern is contained. By the measure of the paper, this may be easily tried with a pair of compasses, and will be found to be nearly $6\frac{4}{10}$ inches in length, by $3\frac{6}{10}$ inches in breadth. Now, if this is to be woven in a reed containing 800 intervals in 37 inches, and if every interval contains five threads, supposed to be contained between every two parallel lines, the length will be 6·24 inches, and the breadth 3·52 inches nearly, so that the figure upon the cloth would be very nearly of the same dimensions as that upon the paper; but if a 1200 reed were used instead of an 800, the dimensions would be proportionally contracted. A correct idea being formed of the design, the weaver may proceed to mount his loom according to the pattern, and this is done by two persons, one of whom takes from the design the instructions necessary for the other to follow in tying his cords. It remains only for us now to take notice, very shortly, of figs. 15, 16, and 17.

*Dornock and Diaper.*—Figures 15, 15. This figure is a representation of the most simple species of table linen, which is merely an imitation of checker work of various sizes, and is known in Scotland, where the manufacture is chiefly practised, by the name of Dornock. When a pattern is formed upon tweeled cloth, by reversing the flushing, as formerly explained, the two sides of the fabric being dissimilar, one may be supposed to be represented by the black marks, and the other by the part of the plate which is left uncoloured. For such a pattern as this it is perfectly unnecessary to have recourse to the draw loom, for two sets of common tweel heddles, moved in the ordinary way, by a double succession of heddles, are quite sufficient. The other part of fig. 15 is a design of that intermediate kind of ornamental work which is called diaper, and which partakes partly of the nature of the Dornock, and partly of that of the damask and tapestry. The principle upon which all these species of goods are woven is entirely the same, and the only difference is in the extent of the design, and the means by which it is executed.

The last figure, 17, is a design for a border of a handkerchief or napkin, which may be executed either in the manner of damask, or as the spotting is practised in the lighter fabrics.

WEAVING-LOOM. *See* LOOM.

WEB, a tissue or texture formed of threads interwoven with each other; some whereof are extended in length, and called the warp; and others drawn across, and called the woof.

WEDGE, one of the five mechanical powers, or simple engines, being a geometrical wedge, or very acute triangular prism, applied to the splitting of wood, rocks, or raising great weights. *See* MECHANICS.

WEIGH, WAY, or *Wey*, (waga,) a weight of cheese, wool, &c. containing 256 pounds avoirdupois. Of corn, the weight contains forty bushels; of barley or malt, six quarters. In some places, as Essex, the weight of cheese is 300 pounds.

WEIGHING-ENGINES, are often constructed in order to ascertain the weight of the loads on waggons and carts passing along turnpike roads. To prevent the roads from being too much worn, it has been found expedient to fix by an act of parliament a certain load for each breadth of wheel; and, that such loads may not be exceeded, there are weighing machines at several of the toll-gates, by which the loads of the several waggons, &c. passing through them can be determined. In some of these machines the contrivance is such, that the carriage whose load is to be weighed is lifted clear from the ground, by means of four strong chains and hooks attached to a large steel-yard, whose fulcrum is raised commonly by a combination of tooth and pinion-work, moved by a winch handle; but it is far better to have the business performed by means of apparatus placed under a horizontal frame on which the carriage may be drawn. The most compendious and economical machine of this kind that we have seen, is one, first used for weighing the riders of race horses, and afterwards applied to the more reputable service of weighing loaded carriages.

The annexed figure is a plan of the machine; K L M N is the plan of a rectangular box, which has a platform lid or cover of size sufficient for placing the wheels of a cart or waggon. The box is about a foot deep, and is sunk into the ground till the platform cover is even with the surface. In the middle of the box is an iron lever supported on the fulcrum pin *i k*, formed like the nail of a balance, which rests with its edge on arches of hardened steel firmly fastened to the bottom of the box. This lever goes through one side of the box, and is furnished at its extremity with a hard steel pin *l m*, also formed to an edge below. In the very middle of the box it is crossed by a third nail of hardened steel *g h*, also formed to an edge, but on the upper side. The three edges are in one horizontal plane, as in a well-made balance. In the four corners, A, A′, E′, E, of the box are firmly fixed four blocks of tempered steel, having their upper surfaces formed into spherical cavities, well polished and hard tempered. A B C D E represents the upper edge of an iron bar of considerable strength, which rests on the cavities of the steel-blocks in A and E, by means of two hard steel studs projecting from its under edge, and formed into obtuse-angled points or cones. These points are in a straight line parallel to the side K N of the box. The middle part C of this crooked bar is faced with hard tempered steel below, and is there formed into an edge parallel to A E and K N, by which it rests on the upper edge of the steel pin *g h*, which is in the lever. In a line parallel to A E, and on the upper side of the crooked bar A C E, are fixed two studs or points of hardened steel B and D projecting upwards above half an inch. The platform cover has four short feet like a stool terminated by hard steel studs, which are shaped into spherical cavities and well polished. With these it rests on the four steel points B, B′ D′, D. The bar A C E, is kneed in such a manner vertically, that the points A, B, D, E, and the edge C, are all in a horizontal plane. These particulars will be better understood by looking at the elevation in fig. 6. What has been said of the bar A C E must be understood as also said of the bar A′ C′ E′.

Fig. 5

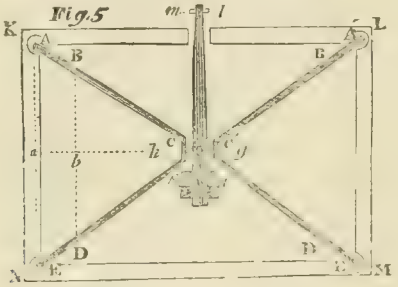
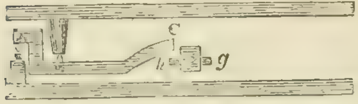


Fig. 6.



Draw through the centre of the box the line *a b c* perpendicular to the line A E, B D. It is evident that the bar A C E is equivalent to the lever *a b c*, having the fulcrum or axis A E resting with its extremity C on the pin *h g*, and loaded at *b*. It is also evident that *a c* is to *a b* as the load on this lever to the pressure which it exerts on the pin *g h*, and that the same proportion subsists between the whole load on the platform, and the pressure which it exerts on the pin *g h*. It will also appear on an attentive consideration, that this proportion is no wise deranged in whatever manner the load is placed on the platform. If very unequably, the two ends of the pin *g h*, may be unequally pressed, and the lever wrenched and strained a little; but the total pressure is not changed. If there be now placed a balance or steel yard L K, in such a manner that one end of it may be directly above the pin *l m* in the end of the lever E O F they may be connected by a wire or slender rod, and a weight on the other arm of the balance or steel-yard may be put in equilibrio with any load that can be laid on the platform. A small counterpoise being first hung on to balance the apparatus when unloaded, any additional weight will measure the load really laid on the platform. If *a b* be to *a c* as 1 to 8, and E O to E F also as 1 to 8, and if a common balance be used above, 64 pounds on the platform will be balanced by one pound in the scale, and every pound will be balanced by one-fourth of an ounce. This would be a very convenient partition for most purposes, as it would enable us to use a common balance and common weights to complete the machine; or it may be made with a balance of unequal arms, or with a steel yard.

Some have thought to improve this instrument by using edges like those of the nails of a balance instead of points. But unless made with uncommon accuracy, they will render the balance very dull. The small deviation of the two edges A and E, or of B and D, from perfect parallelism to K N, is equivalent to a broad surface equal to the whole deviation. We imagine, that with no extraordinary care, the machine may be made to weigh within $\frac{1}{2000}$ of the truth, which is exact enough for any purpose in commerce.

It is necessary that the points be attached to the bars. Some have put the points at A and E in the blocks of steel fastened to the bottom, because the cavity there lodged water or dirt, which soon destroyed the instrument with rust. But this occasions a change of proportion in the first lever by any shifting of the crooked bars: and this will frequently happen when the wheels of a loaded cart are pushed on the platform. The cavity in the steel stud should have a little rim round it, and it should be kept full of oil. In a nice machine a quarter of an inch of quicksilver would effectually prevent all these inconveniences. The simplest and most economical form of this machine is to have no balance or second steel-yard; but to make the first steel-yard E O F a lever of the first kind, *viz.* having the fulcrum between O and F, and allow it to project far beyond the box. The long or outward arm of this lever is then divided into a scale of weights commencing at the side of the box. A counterpoise must be chosen, such as will, when at the beginning of the scale, balance the smallest load that will probably be examined. It will be convenient to carry on this scale by means of eke-weights hung on at the extremity of the lever, and to use but one moveable weight. By this method the divisions of the scale will have always one value. The best arrangement is as follows: place the mark 0 at the beginning of the scale, and let it extend only to 100, if for pounds, or to 112 if for cwts.; or to 10 if for stones; and let the eke-weights be numbered 1, 2, 3, &c. Let the lowest weight be marked on the beam. This is always to be added to the weight shewn by the operation. Let the eke-weights stand at the end of the beam, and let the general counterpoise always hang at 0. When the cart is put on the platform, the end of the beam tilts up. Hang on the heaviest eke-weight that is not sufficient to press it down. Now complete the balance by sliding out the counterpoise. Suppose the constant load to be 312 lbs. that the counterpoise stands at 86, and that the eke-weight is 9; we have the load $= 986 + 312 = 1298$ lbs.

**WEIGHT**, gravity, in Physics, a quality in natural bodies, whereby they tend downwards towards the centre of the earth.

**WEIGHT**, pondus, in Mechanics, is any thing to be raised, sustained, or moved by a machine, any thing that in any manner resists the motion to be produced.

**WEIGHT**, in Commerce, denotes a body of a known weight, appointed to be put in the balance against other bodies, whose weight is required.

**WEIGHTS**, Modern, English. *See* MEASURES.

**WEIGHTS**, and *Measures*. The standard of measures were originally kept at Winchester, which measure was, by the law of king Edgar, ordained to be observed through the kingdom.

**WELD**, or **WOALD**, (*resede luteola, Linn.*) is a plant cultivated in Kent, Herefordshire, and many other parts of this kingdom. The whole of the plant is used for dyeing yellow; though some assert that the seeds only afford the colouring matter. Two sorts of weld are distinguished: the bastard or wild, which grows naturally in the fields; and the cultivated, the stalks of which are smaller, and not so high. For dyeing, the latter is preferred, it abounding more in colouring matter. The more slender the stalk, the more it is valued. When the weld is ripe

Fig. 1

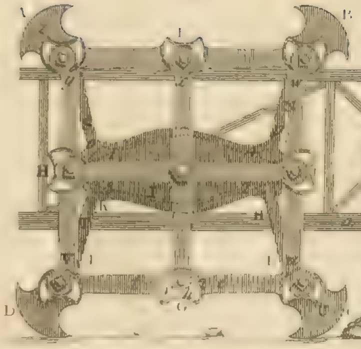


Fig. 2

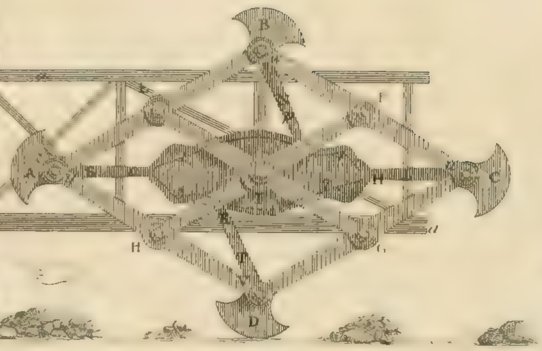


Fig. 3

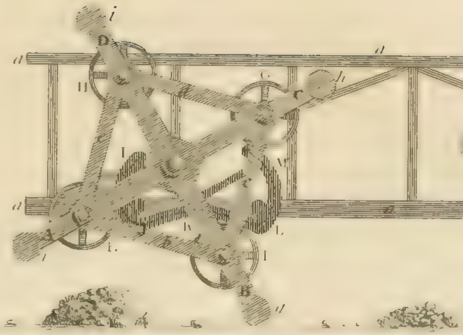


Fig. 4

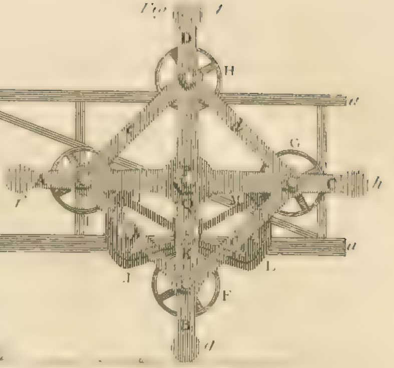


Fig. 5

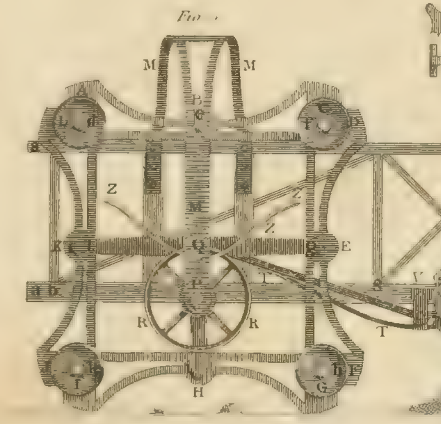


Fig. 12

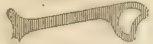


Fig. 13

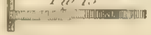


Fig. 6

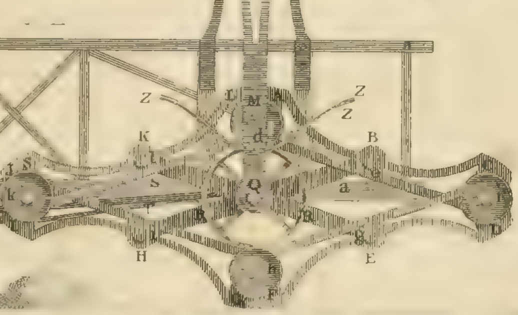


Fig. 14

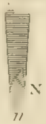


Fig. 15

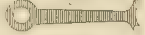


Fig. 16

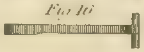


Fig. 18

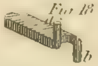


Fig. 17

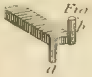


Fig. 7

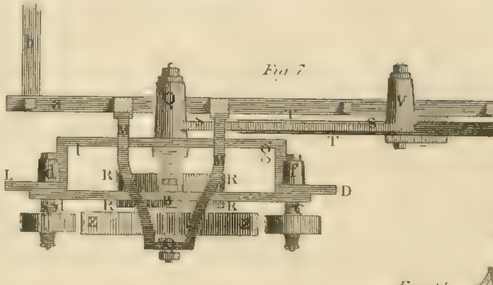


Fig. 22

Fig. 24

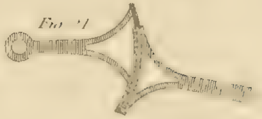


Fig. 19

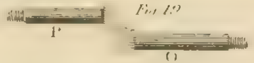


Fig. 20

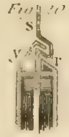


Fig. 21

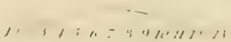


Fig. 26

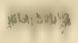


Fig. 25

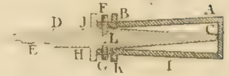


Fig. 23

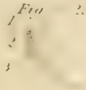


Fig. 8

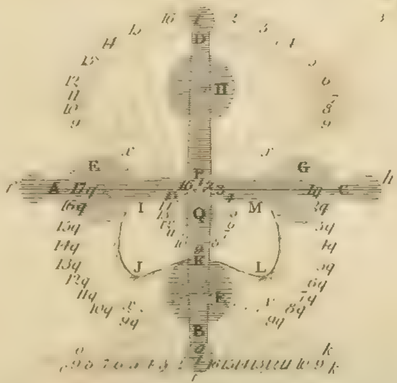


Fig. 9

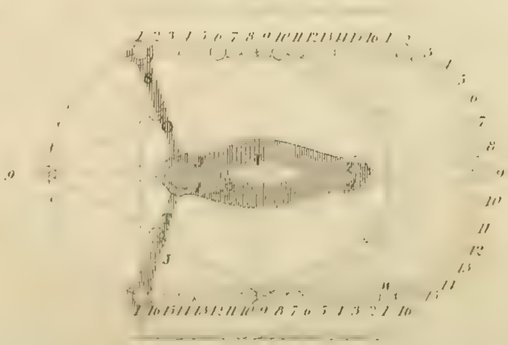


Fig. 10

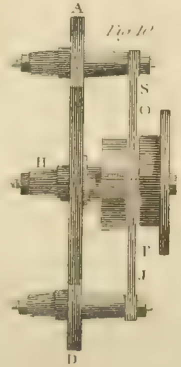
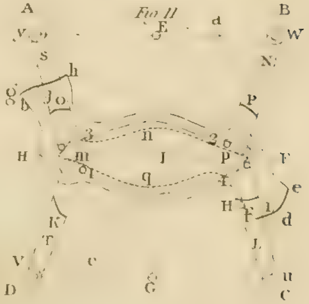


Fig. 11



it is pulled, dried, and made into bundles, in which state it is used. The yellow communicated to wool, by weld, has little permanency, if the wool be not previously prepared by some mordant. For this purpose alum and tartar are used, by means of which this plant gives a very pure yellow, which has the advantage of being permanent.

**WELDING.** Welding is that intimate union produced between the surfaces of two malleable metals, when heated almost to fusion, and hammered. This union is so strong, that when two bars of metal are properly welded, the place of junction is as strong, relatively to its thickness, as any other part of the bar. Only two of the old metals are capable of firm union by welding, namely platina and iron; the same property belongs to the newly discovered metals, potassium and sodium.

**WELDING HEAT**, in Smithery, a degree of heat given to iron, &c. sufficient to make any two bars or pieces of iron unite by a few strokes of the hammer, and form one piece.

**WELL**, in naval affairs, an apartment formed in the middle of a ship's hold, to enclose the pumps from the bottom to the lower deck. Its use is to defend the pumps from damage, and prevent the entrance of ballast, &c. which would otherwise choke the tubes in a short time, and render the pumps incapable of service. By means of this enclosure, the artificers may likewise more readily descend into the hold, to examine or repair the pumps as occasion requires.

**Well** *of a Fishing Vessel*, an apartment in the middle of the hold, which is entirely detached from the rest, being lined with lead on every side, and having the bottom thereof perforated with a number of small holes, through the floor, so that the water passing into the well is always as fresh as that in the sea, and is nevertheless prevented from communicating with other parts of the hold. Its use is to preserve the fish alive which are put into it.

**Well**-*Room of a Boat*, the place in the bottom where the water lies between the ceiling and the platform of the stern sheets, from whence it is thrown out into the sea with a scoop.

**WERST**, or **Verst**, a Russian linear measure, equal to 3500 English feet.

**WHALE.** Balæna.

**WHARF**, a perpendicular building of wood or stone raised on the shore of a road or harbour, for the convenience of loading or discharging a vessel by means of cranes, tackles, capstans, &c. A wharf is built stronger or slighter in proportion to the effort of the tide or sea which it is to resist, and to the weight which it is intended to support.

**WHARFINGER**, the person who has the charge of a wharf, and takes account of all the articles landed thereon, or removed from it, for which he receives a certain fee called *wharfage*, as a due to the proprietor for the rent of the quay or wharf, and for the use of his machines and furniture.

**WHEAT.** *See* Triticum and Husbandry.

**Wheat-ear.** *See* Motacilla.

**WHEEL**, in Mechanics, a simple machine consisting of a round piece of wood, metal, or other matter, which revolves on an axis. The wheel is one of the principal mechanic powers; it has place in most engines; in effect, it is of an assemblage of wheels that most of our engines are composed. *See* Mechanics and Mill.

We shall here introduce to the reader's notice a substitute for wheels, denominated *Scapers*, the ingenious invention of L. Gompertz, Esq., on the accuracy of which the utmost reliance may be placed, it having been derived from the most unquestionable authority, accompanied with a beautifully engraved plate of the diagrams by Lowry:—

**Wheels**, *Substitutes for*, termed **Scapers**, are certain pieces of mechanism, for which a patent has been granted to Mr. Lewis Gompertz, intended generally to supersede wheels for carriages, which, while they support the carriage without rising and falling, also escape the chief obstacles and friction of the ground, produced by the asperities or softness of its surface, by which means a much lighter draught, and a more equable motion, is obtained, and the destruction of the gravel in the road prevented.

Our limits not allowing a full detail of the numerous modifications of this machine, we refer our readers, first, to the Repertory of Arts, second series, No. CLIV. vol. 26; secondly, to vol. 39, number for June 1821; and thirdly, to the inventor's work, "Moral Inquiries;" where there are several varieties of scapers explained, some of which form a sort of rail-way for themselves as they go, while others act without a rail-way, and go with still less friction. Part of the advantages promised by this invention may readily be conceived, when it is considered how many horses a common road requires, for one on a rail-way.

The action of carriage wheels is observed by the inventor as not being generally well understood. (See his observations in No. CLXIX. vol. 29, Repertory.) He also considers the opposition presented to wheel carriages, even on a smooth surface, to be much greater than is generally believed; and, in support of these ideas, adds the testimony of the late learned M. Charles Bossut, who, in his "Cours de Mathématique, tome troisieme," treats of two sorts of friction; one of "bodies *qui glissent*," (which slide,) and the other of bodies "*qui tournent*," (which turn, without alluding to the axle,) and where M. Bossut further observes, that "the existence of the latter species of friction has been overlooked by those who were, in other respects, good mechanics." The inventor has completed several small and large models of these scapers, which he found to work well; though he is, we believe, still engaged in further improvements upon them. We shall omit the first plans in the Repertory, vol. 26, and proceed, first, to those vol. 39; and secondly, to those in "Moral Inquiries."

Figs. 3 and 4 shew the simplest, though not the best species of scapers. *a*, *a*, *a*, *a*, is the frame of a carriage, with two of these scapers in different positions; A B C D are two *crosses*, strengthened, if necessary, with pieces, *b*, *c*, *d*, *e*. The ends or feet, *f*, *g*, *h*, *i*, of the crosses being circular, as shewn, and these should be six inches wide, or more. These crosses move along the road by bearing on each foot alternately, and though they have themselves the evil of rising and falling in their centres of gravity, they do not allow the carriage to be thus affected: the operation is as follows;—Fig. 19 is a double axle, parallel and in opposite directions to each other, whose parallel distance from centre to centre is exactly half of what the centre of the cross rises and falls. The longest axle Q works in a box or tube in the carriage, and axle P in a box in the cross, and they make a whole revolution at every change of foot, so that when the leg which is on the ground is perpendicular to the ground, axle P is full upwards; and when two feet touch level ground at once, the axle P is quite downwards; the centres, then, of the cross, consequently, will move in a circle whose diameter is the whole distance of the rise and fall, by which means the cross will be prevented, though it rises and falls itself, from communicating that motion to the carriage. The motion this crank allows to the centre, effects two objects: first, it gives the rise and fall; and secondly, it causes the scaper to surmount those obstacles gradually upon which the feet happen to alight, contrary to what would take place if the centre moved up and down in a right line.

The motion of the cross is then guided by four wheels E, F, G, H, one situate on each leg, as shewn, which continually bearing against a properly curved iron or sweep, I J K L M, affixed to the carriage, produces the effect required, and which would, if not for side pressure, guide the motion without the crank.

A superior sort of scaper is shewn in figs. 1 and 2, in two positions, each of which consists of a parallelogram. A, B, *w*, *u*, C D and *y* V, moveably jointed at *y*, V, *u*, *w*; E G H F are two cross pieces jointed to the middle of each of the former pieces, A B, C D *w u*, and *y*; V the centre of the cross pieces E G H F have a box for an axle to go through, and one of these boxes fits into the other; this axle being fixed in the carriage, and on which the parallelogram is placed as a common wheel. These eight joints allow this frame to open and shut, and constitute the chief of the scaper, turning round as it goes, and continually opening and shutting; by which means it runs without raising or sinking the carriage. A B C D are four feet, each consisting of a quarter of a circle, or a very little more, described from the joints to which they belong; and in fig. 1, from the *Rolling Angle*, (see the sequel); so that some part of the foot is always perpendicularly under the joint. Two of these feet are formed on one side D G C, and two on the opposite side A E B; the two other sides being without any. This frame then being a parallelogram, and the centre being fixed, the two joints which are diagonally opposite, will, in all their motions, be similar; therefore, if a straight guide were affixed to the carriage near the top of the parallelogram, and four small rollers were attached to the joints V *u*, *w*, *y*, so that they bore on the top of this straight piece, then would the scaper be properly guided when on level ground. And if another straight piece were placed above this, forming a groove with the lower piece, the little wheels would bear upwards against it when the feet came upon an elevation or depression of ground, and it would for a time guide the motion instead of the lower piece. Or these straight guides might be fixed *below*, so as to conduct the wheels in the lower part of their circuit. But the following and better way of guiding has been adopted by the inventor in his models, as possessing less friction:—

It is to be observed, that when the top and bottom joints V and *w*, fig. 2, describe right lines on the carriage, as it moves along, the intermediate joints *u* and *v*, describe curves relative to the carriage, very nearly resembling parts of circles (on both sides) drawn through the three centres of the joints *u* and *w*, fig. 1 of the plate, when the parallelogram is square, and through the joint between them, where the joints reach when fully extended, (as in fig. 2); and a similar observation applies to the other side *y* V. The diagram, fig. 9, contains this circle and the true curve shewn together, with the difference that exists between them, the true curve being numbered from 1 to 16, and small circles drawn to shew the axle as it goes. It is obvious, that if the joints, which are not on the ground, be by any means guided in this curve, then will the top and bottom joints also be properly guided; and it is by conducting these intermediate joints, that the motion is governed, with less friction than by the curve itself. Because as the curve differs but little from a circle, the means exist of attaching a radius or arm to the centre of each joint, (so that it can turn round,) reaching nearly to the centre of the circle, which the curve resembles, and to place a much smaller curve partly round it, of such figure, that when the arms are by any means caused to point to the centre of the circle in fig. 23, which also represents the centre of the large circle in fig. 9, while a pin in the end of the arms properly traverses this curve, then the joint to which it is attached will be guided in the true curve, 1, 3, 15, 16, &c. in the same way as if it were guided by the curve itself, though with much less friction. But this little curve alone will not restrain the arm in a line with the centre, and the following method has therefore been adopted.

The four arms S O, J K, L H, and N P, figs. 15, 16, and 18, have two pins or rollers at the end of each of them, (not opposite, but reversed,) which guide the motion. One of these pins is on one side of the arm, and one on the other, in contrary directions, and at a small distance from each other, as shewn, and they work round two similarly curved guides, 1, 2, 3, 4, figs. 1, 2, and 9, fixed in the carriage, but whose curvature is also reversed. One of these guides in the plate hides the other, and which is itself put out of sight by its own back, but both are dotted to shew them; and they are fixed to the carriage, the two facing each other, (as a box faces its lid,) leaving a space between them for the arms, which work between the two, one of the pins or rollers of the arms working in the one curve, and one in the other, each bearing half the pressure.

Especial care must be taken not to fix the pins on the wrong side of the arms, or the curves with the wrong faces to the carriage and parallelogram. Thus in fig. 18, the pins suit, supposing the guide, of which the back is seen in fig. 2, to be next to the parallelogram, or when faced, as in the plate, and in fig. 17, they would suit, if the back of the one now seen were nearest to the body, as shewn in the diagram, fig. 9, but the pins being still reversed to each other, the position of the curves not being altered by changing or turning them, or by fixing them end for end. The curves must always be reversed to each other, and there are two ways of reversing them, one answering to arms made as in fig. 18, and the other as in fig. 17. These two rollers then keep each other in their proper position while they work round the small ends of the guide, and during which period they give the proper extension to the feet, thus acting instead of a rail-way. The long part, I, of the guides serves only to conduct the arms to the bearing ends, but scarcely suffers any pressure or friction there. The dark curve in the diagram, fig. 9, is so placed as to answer to the arm 17. The light shaded pin works in the dark curve, and the dark pin in the light curve.

Though the ends of the guides conduct the arms, it is found necessary to cut off a small portion of these ends where the arms enter, and leave these places; which otherwise would contain asperities injurious to the motion. (See Repertory for June 1821.) Though by such means the scaper loses its guidance for a short space, but to supply its place there are affixed to the upper guide two small curves *e*, *i*, *f*, and *g*, *j*, *h*, fig. 11; and there are attached to the parallelogram four small rollers, *a*, *b*, *c*, *d*, which at times bear against the outside of *e*, *i*, *f*, and against the inside of *g*, *j*, *h*; the defect being thus remedied. But the rollers only bear against a small part of these curves, excepting on very unlevel ground, and in that case they keep the parallelogram properly extended, (see the sequel.)

While the arms traverse the long part of the guides, they go inclined, as W *n*, and D *q*, fig. 11; when to prevent their becoming, by any accident, perpendicular, and striking the axle L, the lower guide, (but not the upper one,) is furnished with an inside projection *m*, *n*, *p*, *q*, forming a groove with the guide itself, (but found to require more width near the corners than in any other place,) and in this groove one of the rollers of the arms works, thus keeping the arm properly inclined, and in the same direction, whether the carriage goes from right to left, or left to right. Or the upper guide, instead of the lower, may have such a projection, and then the arms will traverse in the direction shewn in figs. 2 and 9. But as this inside projection will not serve when the parallelogram is nearly square, two small pins, O and H, fig. 11, are affixed between the upper guide and the curves *g*, *j*, *h*, and *e*, *i*, *f*, which by bearing loosely against a small projection upon each of the arms near P H K and O, keep the arms by that means right; these small projections having the peculiar and required property of causing the arms to enter the end portions of the guides in one position, and leaving them in another. Though only one guide must have the inside projection *m*, *n*, *p*, *q*, a small piece in the other, near *m* and *p*, is also serviceable in preventing the foot from being pushed back when fully extended, as A, C, fig. 2. In fig. 11, the outside plain line is the exterior of the top guide; the next plain line is the interior; the outside dotted line is the interior of the lower guide; and the inside dotted line is the inside projection. Fig. 10 is an end view of the scaper, the same letters referring to the same parts, and fig. 24 is one of the guides divided into lines of proper lengths, to express its shape.

In fig. 2 the scaper is shewn, supposing it jointed with common round axii, and boxes, but in fig. 1 the pins *v*, to avoid friction, are so contrived as to *roll* round within their boxes G *h*, upon a rounded angular side *h*, where the chief pressure exists, leaving the other two angular sides of the pins to slide, the insides of the boxes then being properly curved, keep the whole steady in its motion. Figs. 12 and 13 are the arms made after the same plan, and in fig. 14 N *n* is a front view of the pins upon the sides of the parallelogram. In order for the carriage to turn, the front scapers may be made to swing as common wheels; but it is far preferable for each front scaper to swing separately on a perpendicular axis immediately above itself, and then, as great steadiness is required, the guide of the front and back scaper should be connected by two circular pieces sliding within each other, shewn in fig. 21. *n*, *n*, S *y*, *v*, fig. 20, is a section of the guides, arms, and rollers, which are here suggested, in a peculiar form, to defend themselves from mud.

The last species of scaper we have to describe is shewn in figs. 5, 6, and 7. Fig. 7 being a kite view of fig. 5, the top rail of the carriage being removed. This sort of scaper is inferior to the last in point of friction; it is also rather less equable and quiet in its motion, and does not allow so much facility to the carriage in turning, but is of great strength, and better surmounts large obstacles when the feet happen to come upon them. It is also more calculated for uneven roads, owing to a peculiar property of changing its form and action according to the ground, so as to surmount those asperities which it does not escape, gradually, and effecting this in every instance while the carriage moves the length of a whole side of the parallelogram, instead of a small portion, as in the other species. It has also the advantage of always supporting the carriage nearly from the same place, because there are always two feet on the ground at once, excepting when the feet are themselves nearly under the main axle; whereas in all the other species, the points of support greatly vary. *a*, *b*, *a*, figs. 5 and 6, is the carriage. A C, D F, G I, and J L, are the four sides of the parallelogram, jointed at *a*, *f*, *h*, *k*, *l*, *g*: *e i* and *l g* are two cross pieces, jointed at *l*, *g*, *e*, and *i*, bent, as shewn at L *l*, *g* D, fig. 7, *e*, *i*, being hidden in this figure; and M M, Q P, is a standard or piece, which, in a front view, would appear thus

; the part *a* shewing where it is attached to the frame *a*, *a*, and Q representing an axle fastened in the other end of it, upon which goes a large wheel R R, wide enough to bear on all the sides of the parallelogram in turn, on which it runs. S, V, Q is a lever, one end being jointed to the frame on an axle at V, and the other end jointed to the centre of the parallelogram, with a long tube V at one end, and another tube Q in the other end; while one tube works on the axle in the frame at V, and the other on the *outside* of another tube Q in the cross piece *g l*. The other cross piece *e*, *i*, in this machine, being furnished with an axle to go in the tube in the cross piece *g*, *l*. This lever allows the centre of the parallelogram to rise and fall without the carriage. T T is a spring to assist the scaper to change its position from that of fig. 6 to that of fig. 5, the spring being shewn on the other side (for the other scaper) likewise the lever S Q; and as the tube Q must work past the frame *a*, *a*, the frame must have an opening in it to allow the axle Q to pass, unless the scaper should be fixed further from the frame, or the tube Q made shorter, or unless the body be placed rather higher than shewn. A *d*, C *f*, G *h*, and I *k*, figs. 5 and 6, are four rollers on the end joints of the parallelogram, and Z Z Z is a properly shaped curve, firmly attached to the frame or standard M, into which these rollers pass, causing the feet to come down gently. As this curve bears up the feet, it likewise would slightly raise the carriage; but to prevent this, the sides of the parallelogram on which wheel R runs, though straight for nearly their own length, are a little curved near the ends accordingly. In this sort of scaper, as two feet remain long on the ground at once, it is necessary for the joints to play, to allow the carriage to turn, and a joint, shewn in fig. 25, though too long, shews one way of making them. J H L C is the axle, B A the box, E the axle of the rollers A *d*, C *f*, G *h*, and I *k*, figs. 5 and 6. and F G, fig. 25, are the screws fitting in a groove in the axle, but allowing it to play.

Owing to the property in this species of scaper of supporting the carriage always nearly in the same place, they may suit best two to a body, instead of four, and fixed nearly in the middle. One small *common* wheel may then be placed in front, without bearing more weight than just to balance it, and by means of a swivel, so as to turn. The diagrams, figs. 8, 9, 11, and 24, shew how to project some of the different curves regulating the motions, the other curves being also described in the works we have cited.

In order to project the curve I J L M, figs. 3 and 4, draw a right line *o k*, fig. 8, equal to the span of the feet taken from the centers of the little circles F G H I, and also draw the cross with the wheels and centers, lettered as in fig. 8. Divide this line into a number of equal parts, call the middle of it 1, and figure towards letter *o*, 2, 3, 4, 5, 6, 7, 8, 9, and towards *k*, 16, 15, 14, 13, 12, 11, 10, 9, draw circles the size of the feet round each of these divisions, and also draw a line *k f c*, touching them, (merely to shew the ground,) then from *g* erect a perpendicular *g i*, the height of the cross; at the upper end also draw the foot circle, *i*, as on the cross, and bisect this line shewn at P, also placing No. 1 at the point of bisection; take then a space from this point P or 1, downward, equal to the parallel distance of the centers of the axii P and Q, fig. 19, and mark a point Q on it. Then proceed by drawing a circle round this point Q, through the middle P of the perpendicular *g i*. With the distance then, from the top P of the circle P Q, to No. 1 in the line *o k* in the compasses, fix them at No. 2 in line *o k*, and intersect the circle P Q in an opposite direction, with the same distance, next from No. 3, line *o k*, proceed in this way to No. 9; also in the opposite direction of the circle P Q, and line *o k*, and mark each intersection of circle P Q. Continue, by numbering the intersections from 1, (in the direction P M K P,) 2, 3, 4, 5, 6, till 16, the little circles representing the axle in its various positions, being drawn in the diagram round the points; and draw right lines, the length of the cross through each of the points, so as to touch line *o k*, at the same numbers as the numbers of the points through which they pass, representing the legs when they are most perpendicular in their different positions, and the two dotted wheels *x x*, shew the position of the leg wheels, when two feet bear at once on level ground; and the upper circles, 1, 2, 16, &c. shew part of the direction of the motion of the upper ends of the cross, which if continued, would form a loop on each side, while the lower feet go in a right line. Continue, by taking the distance between the centre of the leg wheel *v g* and line *o k* in the compasses; fix one leg of them on each of the numbers in line *o k*, and with the other compass point mark those lines that are of the same number as the lines in which the compasses are fixed. This will give all the main part of the curve *x y*, described by the centres of the leg wheels, while these wheels bear the chief weight when the ground is level; and which may also be found by measuring from the circle P, Q, taking the distance *v* P instead of *g v*, and proceeding similarly from the numbers as described, marking each of the lines which are between *x* and *y*.

The use of the remainder of the curve is to keep the axle P of the cross and crank P, Q in its proper direction and velocity, and to support and guide the cross when the feet happen to come on an irregularity of ground, and is found thus:—Take the distance *x y*, from the intersections on each of the lines numbered 9 in the compasses; fix one leg of them on 9 *y* line *o k*, and mark part of a circle *q* beyond *x*, then fix the compasses with the same span on 10 line *o*, *k*, and mark another part of a circle *q*, a little beyond the last, and proceed thus with No. 11, 12, 13, 14, 15, 16. Then take the distance from 9 in circle P Q, to the intersection 9 *x* in the compasses; next fix one leg on 10 in circle P Q, and with the other compass point intersect *q* 10, then from 11, in circle P Q to *q* 11, and continue thus to *q* 1 inclusively; this side of the curve will then be found; after which, repeat the operation on the other side, first with the span *x y*, beginning from 9 *x*, and then by fixing the compasses on line 8, and marking beyond *y*, next at 7, in the same way till 1 inclusively, and number them 8, 7, 6, 5, 4, 3, 2, 1. Continue, by applying the distance from 9 *y* to 9, in circle P Q, and intersect those marks, always placing one leg of the compasses in a point of the same number in circle P Q, as the number of the mark that is to be intersected; and this being done, the whole curve described by the centers of the leg wheels on the machine, will be traced by the marks. Circles the size of the leg wheels must then be drawn round all those points, and the several tops will shew the true form of the whole curve. The lower part of the curve, J, K, L, may also be found, by regulating the foot *g* in a right line, while the crank is turned in the direction it follows when the cross is at work, and at the same time causing the upper edge of the leg wheel *v*, blackened, to mark on a board placed behind it, observing to keep the centre of the crank P, without moving too much either to the right or to the left.

To find the curvature of the ends of the guides, 1, 2, 3, 4, figs. 1 and 2:—First, let the curve 1, 16, &c. fig. 9, which the centers of the joints describe, be found, and which may be shewn, by placing a board behind the joints, (blackened,) while the ground feet are drawn along a straight line the same length as the span of the feet, and the axle being kept still. Or this curve may be found thus:—Describe a circle in the figure which represents the parallelogram when square, touching all the four sides; then fix the points of three needles in a right line in a flat ruler, the same distance apart as the distance between the joints F *u*, or F *w*. Figs. 1 and 2 guide one extreme point along the top or bottom straight sides, 1, 9, 16, conducting the middle point in the circle, when the other extreme point will describe the curve required. Or it may be projected simply with the compasses, by equally dividing the top and bottom sides of the square, and by numbering them in contrary directions, as in fig. 9. Then by fixing one compass point in each of these divisions, on each side 1, 9, 16, &c. with the span of the side of the square between the compasses, and marking with the other point of the compasses, a number of segments of circles near the circle 1, 9, 16, so that each segment gets intersected by one of the same number from the opposite side; and these intersections, numbered in the figure, to shew from whence they originate, will also point out the curve sought for; from which proceed to find the small end curves, according to the following plan:—

Into one end of a flat ruler, the full length of the radius of circle 1, 9, 16, fix the point of a needle answering to the centre of the arm, and near the other end fix two needle points, situate like the centres of the pins of the arms, and between them cut a groove pointing to the one needle point, which groove is to be caused to work and to slide on another needle, fixed in the centre of circle 1, 9, 16, while the single needle point is guided continually by the large curve near circle 1, 9, 16, and then will the two needle points trace out two small curves; round the boundary of each of which, must then be drawn a number of small circles, the size of the pins or rollers, so that the insides of them will shew the true shape of the ends of the curves. Instead of the ruler with points, &c. a piece of transparent horn with holes may be found convenient.

The shape of that part of the curve which connects the two end portions together, is of no decided figure, but still requires great exactness, and is found by repeated trials; which being done, two solid curves are fitted to the figures of the whole guides, reversedly screwed together, and this serves for a model or core on which to make and affix the guides themselves; taking care that the guides be fixed exactly horizontally; and for which purpose, draw a line from 9 to 9, fig. 9, horizontally, (supposing the figure in its natural position,) marking the double guide into two equal and similar portions. This then must be fixed, so that the two halves into which the line cuts the curve, be similarly siuate to the two sides of the figure of the diagram, the centre, I, being in the middle.

The shape of the curves *g*, *j*, *h*, and *e*, *i*, *f*, fig. 11, is easily found by causing the feet to move in a right line, and observing the trace of the rollers on a board properly fixed, during the short time when the arms become useless, and also whilst the feet are approaching or leaving the level line of the ground; which part of the curves the rollers *a a*, *c b*, will bear against as they pass when the ground is unlevel, the feet being by this means kept in their proper course.

The curve Z Z Z, figs. 5 and 6, is found at pleasure, so as to give an easy motion to the feet, in approaching and leaving the ground; and owing to the circular motion of the lever V S the two halves, Z Z and Z, will differ. But this curve, while it bears up the feet, tends also to raise the parallelogram, the sides of which are therefore very slightly curved, to prevent this evil from taking place; and the curvature is found, by causing the feet to move in a right line, observing the shape described by the flat face of the wheel R on the sides of the parallelogram.

In the diagram, fig. 9, the feet are shewn dotted, of a better shape than those in figs. 1 and 2, which construction prevents their suddenly falling off by any obstacle.

Fig. 26, is a screw for the nuts, or for other purposes, in which the side of the thread bearing the pressure is perpendicular, and the other side doubly inclined, thus uniting the strength of an angular thread to the advantage of a flat thread, *viz.* of preventing the nuts from bursting.

WHERRY, a name given to several kinds of light boats used on the sea-coast and up rivers. *Wherry* is also applied to some decked vessels used in fishing, in different parts of Great Britain and Ireland.

WHIP, among Sailors, a sort of small tackle, formed by the communication of a rope with a single immoveable block, or with two blocks, one of which is fixed and the other moveable; used to hoist up light bodies, such as empty casks, &c.

Whip, or *Whip Staff*, is a piece of timber in form of a strong staff, fastened into the helm for the steersman, in small ships, to hold in his hand, in order to move the rudder, and direct the ship.

WHIRLING Table, a machine intended to represent the several phenomena in philosophy and nature, as the principal laws of gravitation, and of the planetary motions.

WHIRLPOOL, an eddy, vortex, or gulf, where the water is continually turning round. In rivers these are very common from various accidents, and are usually very trivial and of little consequence. In the sea they are more rare, but more dangerous. Sibbald has related the effects of a very remarkable marine whirlpool among the Orcades, which would prove very dangerous to strangers, though it is of no consequence to the people who are used to it. This is not fixed to any particular place, but appears in various parts of the limits of the sea, among those islands. Wherever it appears, it is very furious, and boats, &c. would instantly be drawn in and perish thereby, but the people who navigate them are prepared for it, and always carry an empty vessel, a log of wood, or a large bundle of straw, or some such thing, in the boat with them; and as soon as they perceive the whirlpool, they toss the article within its vortex, and thus keep themselves out of it. This substance, whatever it be, is immediately received into the centre and carried under water; and as soon as this is done, the surface of the place where the whirlpool was, becomes smooth, and they row over it with safety, and in about an hour they see the vortex begin again in some other place, usually about a mile distant from the other.

WHIRLS, small hooks fastened into cylindrical pieces of wood, which communicate by means of a leather strap with a spoke-wheel, whereby three of them are set in motion at once; they are used for the spinning of yarn for ropes.

WHIRLWIND, is a wind that rises suddenly, and is exceeding rapid and impetuous when risen, but soon spent. There are divers sorts of whirlwinds distinguished by their peculiar names, and the Prester, Typho, Turbo. Exhydria, and Ecnephias. The prester is a violent wind, breaking forth with flashes of lightning. This is rarely observed, and scarce ever without the ecnephias. Seneca says it is a typho, or turbo rekindled, or ignited in the air. A typho or vortex, most properly called whirlwind, or hurricane, is an impetuous wind, turning rapidly every way, and sweeping all round the place. It usually descends from on high, and is frequent in the eastern ocean, chiefly about Siam, China, &c. which renders the navigation of those parts very dangerous. The exhydria is a wind bursting out of a cloud with a great quantity of water. This only seems to differ in degree from the ecnephias which is frequently attended with showers. The ecnephias is a sudden and impetuous wind breaking out of some cloud, frequent in the Ethiopic sea, particularly about the Cape of Good Hope, and is generally called by seamen a travado.

Dr. Franklin, in his physical and meteorological observations, supposed a water-spout and a whirlwind to proceed from the same cause, their only difference being, that the latter passes over the land, and the former over the water. This opinion is corroborated by M. de la Pryme, in the Philosophical Transactions, where he describes two spouts observed at different times in Yorkshire, whose appearances in the air were exactly like those of the spouts at sea, and their effects the same as those of real whirlwinds. Whirlwinds have generally a progressive as well as a circular motion; so had what is called the spout at Topsham, described in the Philosophical Transactions; and this also by its effects appears to have been a real whirlwind. Water-spouts have also a progressive motion, which is more or less rapid, being in some violent, and in others barely perceptible. Whirlwinds generally rise after calms and great heats; the same is observed of water-spouts, which are therefore most frequent in warm latitudes. The wind blows every way from a large surrounding space to a whirlwind. Three vessels, employed in the whale fishery, happening to be becalmed, lay in sight of each other at about a league distance, and in the form of a triangle. After some time a water-spout appeared near the middle of the triangle, when a brisk gale arose, and every vessel made sail. It then appeared to them all, by the trimming of their sails, and the course of each vessel, that the spout was to leeward of every one of them; and this observation was further confirmed by the comparing of accounts, when the different observers afterwards conferred about the subject. Hence whirlwinds and water-spouts agree in this particular likewise. But if the same meteor which appears a water-spout at sea, should in its progressive motion encounter and pass over land, and there produce all the phenomena and effects of a whirlwind, it would afford a stronger conviction that a whirlwind and a water-spout are the same thing. An ingenious correspondent of Dr. Franklin gives (as follows) one instance of this, that fell within his own observation at Antigua, and which convinced him that a water-spout is a whirlwind:—There appeared not far from the mouth of the harbour of St. John's, two or three water-spouts, one of which took its course up the harbour. Its progressive motion was slow and unequal, not in a straight line, but, as it were, in jerks and starts. When just by the wharf, I stood about one hundred yards from it. There appeared in the water a circle of about twenty yards' diameter, which to me had a dreadful though pleasing appearance. The water in this circle was violently agitated, being whisked about and carried up into the air with great rapidity and noise, and reflected a lustre as if the sun shined bright on that spot, which was more conspicuous, as there appeared a dark circle around it. When it made the shore, it carried up, with the same violence, shingles, staves, large pieces of the roofs of houses, &c. and one small wooden house it lifted entirely from the foundation on which it stood, and carried it to the distance of fourteen feet, where it settled without breaking or oversetting; and what is remarkable, though the whirlwind moved from west to east, the house moved from east to west. Two or three negroes and a white woman were killed by the fall of the timber, which it carried up into the air and dropped again.

A fluid moving from all points horizontally, towards a centre, must, at that centre, either mount or descend. If a hole be opened in the middle of the bottom of a tub filled with water, the water will flow from all sides to the centre, and there descend in a whirl. But air, flowing on or near the surface of land, or water, from all sides towards a centre, must, at that centre, ascend, because the land or water will hinder its descent. If these concentring currents of air be in the upper regions, they may indeed descend in the spout or whirlwind; but then, when the united current reached the earth or water, it would spread, and probably blow every way from the centre. There may be whirlwinds of both kinds; but from the effects commonly observed, Dr. Franklin suspected the rising one to be most frequent; when the upper air descends, it is perhaps in a greater body, extending wider, as in thunder-gusts, and without much whirling; and when air descends in a spout or whirlwind, he conceived that it would rather press the roof of a house inwards, or force in the tiles, shingles, or thatch, and force a boat down into the water, or a piece of timber into the earth, than snatch them upwards and carry them away. The whirlwinds and spouts are not always, though most frequently, in the day-time. The terrible whirlwind which damaged a great part of Rome, June 11, 1749, happened in the night, and was supposed to have been previously a water-spout, it being asserted as an undoubted fact, that it gathered in the neighbouring sea, because it could be traced from Ostia to Rome. This whirlwind is said to have appeared as a very black, long, and lofty cloud, discoverable, notwithstanding the darkness of the night, by its continually lightning, or emitting flashes on all sides, pushing along with surprising swiftness, and within three or four feet of the ground. Its general effects on houses were, stripping off the roofs, blowing away chimneys, breaking doors and windows, forcing up the floors, and unpaving the rooms, (some of which effects seem to agree well with the supposed vacuum in the centre of the whirlwind) and the very rafters of the houses were broken and dispersed, and even hurled against houses at a considerable distance, &c.

Doctor Franklin, the better to explain his conceptions, offers the following positions as a foundation for his hypothesis:—"That the lower region of air is often more heated, and so more rarefied, than the upper, and by consequence specifically lighter. The coldness of the upper region is manifested by the hail, which sometimes falls from it in warm weather. That heated air may be very moist, and yet the moisture so equally diffused and rarefied as not to be visible till colder air mixes with it, at which time it condenses and becomes visible. Thus our breath, although invisible in summer, becomes visible in winter."

These circumstances acknowledged, he presupposes a tract of land or sea of about sixty miles in extent unsheltered by clouds and unrefreshed by the wind, during a summer day, or perhaps for several days, without intermission, till it becomes violently heated, together with the lower region of the air in contact with it, so that the latter becomes specifically lighter than the superincumbent higher region of the atmosphere, where the clouds are usually floated. He supposes also, that the air surrounding this tract, has not been so much heated during those days, and therefore remains heavier. The consequence of this he conceives should be, that the heated lighter air should ascend, and the heavier descend; and as this rising cannot operate throughout the whole tract at once, because that would leave too extensive a vacuum, the rising will begin precisely in that column which happens to be lightest or most rarefied, and the warm air will flow horizontally from all parts to this column, where the several currents meeting and joining to rise, a whirl is naturally formed, in the same manner as a whirl is formed in a tub of water, by the descending fluid receding from all sides of the tub towards the hole in the centre. And as the several currents arrive at this central rising column with a considerable degree of horizontal motion, they cannot suddenly change it to a vertical motion; therefore, as they gradually, in approaching the whirl, decline from right to curve or circular lines, so, having joined the whirl, they ascend by a spiral motion, in the same manner as the water descends spirally through the hole in the tub before mentioned.

Lastly, as the lower air nearest the surface is more rarefied by the heat of the sun, it is more impressed by the current of the surrounding cold and heavy air, which is to assume its place, and, consequently, its motion towards its whirl is swiftest, and so the force of the lower part of the whirl strongest, and the centrifugal force of its particles greatest. Hence the vacuum which encloses the axis of the wheel, should be greatest near the earth or sea, and diminish gradually as it approaches the region of the clouds till it ends in a point. This circle is of various diameters, sometimes very large. If the vacuum passes over water, the water may rise in a body or column therein to the height of about thirty-two feet. This whirl of air may be as invisible as the air itself, though reaching in reality from the water to the region of cold air, in which our low summer thunder clouds commonly float; but it will soon become visible at its extremities. The agitation of the water, under the whirling of the circle, and the rising of the water in the commencement of the vacuum, renders it visible below. It is perceived above by the warm air being brought up to the cooler region, where its moisture begins to be condensed by the cold into thick vapour, and is then first discovered at the highest part, which being now cooled, condenses what rises behind it, and the latter acts in the same manner on the succeeding body; where, by the contact of the vapours, the cold operates faster in a right line downwards than the vapours themselves can climb in a spiral line upwards; they climb, however, and as by continual addition they grow denser, they consequently increase their centrifugal force; and being risen above the concentrating currents that compose the whirl, they fly off and form a cloud. It seems easy to conceive, how, by this successive condensation from above, the spout appears to drop or descend from the cloud, although the materials of which it is composed are all the while ascending. The condensation of the moisture contained in so great a quantity of warm air as may be supposed to rise in a short time in this prodigiously rapid whirl, is perhaps sufficient to form a great extent of cloud, and the friction of the whirling air on the sides of the column may detach great quantities of its water, disperse them into drops, and carry them up in the spiral whirl mixed with the air. The heavier drops may, indeed, fly off, and fall into a shower about the spout; but much of it will be broken into vapour, and yet remain visible. As the whirl weakens, the tube may apparently separate in the middle, the column of water subsiding, the superior condensed part drawing up to the cloud. The tube or whirl of air may, nevertheless, remain entire, the middle only becoming invisible, as not containing any visible matter.

In the Philosophical Transactions, Dr. Stuart says, "It was observable of all the spouts he saw, but more perceptible of a large one, that towards the end it began to appear like a hollow canal, only black in the borders, but white in the middle; and though it was at first altogether black and opaque, yet the sea water could very soon after be perceived to fly up along the middle of this canal like smoke in a chimney."

When Dr. Stuart's spouts were full charged, that is, when the whirling pipe of air was filled with quantities of drops and vapour torn off from the column, the whole was rendered so dark that it could not be seen through, nor the spiral ascending motion be discovered; but when the quantity ascending lessened, the pipe became more transparent, and the ascending motion visible. The spiral motion of the vapours, whose lines intersect each other on the nearest and farthest side of this transparent part, appeared therefore to Dr. Stuart like smoke ascending in a chimney; for the quantity being still too great in the line of sight through the sides of the tube, the motion could not be discovered there, and so they represented the solid sides of the chimney.

Dr. Franklin concludes, by supposing a whirlwind or spout to be stationary, when the concurring winds are equal; but if unequal, the whirl acquires a progressive motion in the direction of the strongest pressure. When the wind that communicates this progression becomes stronger above than below, or below than above, the spout will be bent or inclined. Hence the horizontal process and obliquity of water-spouts are derived.

**WHIRLING Table**, a machine intended to represent the several phenomena in philosophy and nature,—as, the principal laws of gravitation, and of the planetary motions.

**WHISPERING-PLACES**, depend upon this principle: if the vibrations of the tremulous body are propagated through a long tube, they will be continually reverberated from the sides of the tube into its axis, and by that means prevented from spreading till they get out of it; whereby they will be exceedingly increased, and the sound rendered much louder than it would otherwise be.

**WHIST**, a well-known game at cards, which requires great attention and silence; hence the name.

**WHISTON, William**, an ingenious English mathematician and divine, was born in 1667, and died in 1752, upwards of 84 years of age. He was author of numerous works on philosophy and religion; of the former, his Theory of the Earth, and his Astronomical Lectures, are the only ones which it is necessary to enumerate in this place.

**WHITEHURST, John**, an ingenious English mechanic and philosopher, was born in the county of Chester in 1713, and died in 1788, in the 75th year of his age.

**WHOODINGS**, those ends of planks which are let into the rabbets of the stem, the stern-posts, &c.

**WIDOW**, a woman who has lost her husband by death. In London, and throughout the province of York, the widow of a freeman is by custom entitled to her apparel, and the furniture of the bed-chamber called the widow's chamber.

**WIFE.** *See* Husband and Wife.

**WILD (A) Roadstead**, implies one that is open, or exposed to the wind and sea.

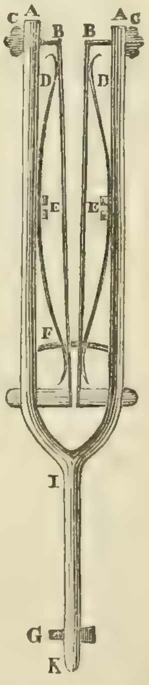
**WILDERNESS**, in Gardening, a kind of groove of large trees, in a spacious garden, in which the walks are commonly made either to intersect each other in angles, or have the appearance of meanders and labyrinths.

**WILDFIRE**, a kind of artificial or factitious fire, which burns even under water, and that with greater violence than out of it. It is composed of sulphur, naphtha, pitch, gum, and bitumen, and is only extinguishable by vinegar mixed with sand and urine, or by covering it with raw hides. Its motion or tendency is said to be contrary to that of natural fire, and it always follows the direction in which it is thrown, whether it be downwards, sideways, or otherwise. Several are of opinion that the ancient Greeks and Romans used this wildfire in their engagements at sea: whether or not that was the case, it was applied against the Saracens in a sea-fight, commanded by Constantine Pogonates, in the Hellespont, and with such effect, that he burnt the whole fleet therewith, wherein there were thirty thousand men. Constantine's successors used it on divers occasions, and with equal advantage; and what is very remarkable, they were so happy as to keep the secret of the composition to themselves, so that no other nation knew it in 960.

**WILL and TESTAMENT**, is that disposition of property which is made by a person to take place after his decease. Every person capable of binding himself by contract, is capable of making a will. Also a male infant of the age of fourteen years and upwards, and a female of twelve years or upwards, are capable of making a will respecting personal estates only. But a married woman cannot make a will, unless a power be reserved in the marriage settlement; but whenever personal property is given to a married woman, for her sole and separate use, she may dispose of it by will. If a femme sole make her will, and afterwards marry, such marriage is a legal revocation of the will. Wills are of two kinds, written and verbal; the former is most usual and secure. It is not absolutely necessary that a will should be witnessed; and a testament of chattels written in the testator's own hand, though it have neither the testator's name nor seal to it, nor witnesses present at his publication, will be good, provided sufficient proof can be had that it is his hand-writing. By statute 29 Charles II. c. 3, all devises of lands and tenements shall not only be in writing, but shall also be signed by the party so devising the same, or by some other person in his presence, and by his express direction, and shall be witnessed and subscribed in the presence of the person devising, by three or four credible witnesses, or else the testament will be entirely void, and the land will descend to the heir at law. A will even if made beyond sea, bequeathing land in England, must be attested by three witnesses. A will, however, devising copyhold land does not require to be witnessed; it is sufficient to declare the uses of a surrender of such copyhold land made to the use of the will. The party to whom the land is given becomes entitled to it by means of the surrender, and not by the will.—A Codicil is a supplement to a will, or an addition made by the person making the same, annexed to, and to be taken as part of, the will itself, being for its explanation or alteration, to add something to, or take something from, the former disposition, and which may also be either written or verbal, under the same restrictions as regards wills. If two wills are found, and it does not appear which was the former or latter, both will be void; but if two codicils are found, and it cannot be ascertained which was the first, but the same thing is devised to two persons, both ought to divide; but where either wills or codicils have date, the latter is considered as valid, and revokes the former.

**WILLOWS, Week's** *Brake for Barking.* The annexed drawing represents a newly invented brake for taking the bark off willows. The object of it is to prevent their being split, as they too often are, in the stripping, on account of the squeezing with the hand. *The hand is not to be applied at all in using these brakes*, springs being substituted, which do the work better, and a great deal more expeditiously.

*Explanation of the Drawing.*—A A is the frame, made of half-inch round iron, about two inches apart, or closer; B B, brake irons to loosen the rind, 11 inches long; C C, screws to adjust the brake irons, according to the size of the rods to be stripped. The wider they are apart on the top, the stiffer they will work at the bottom; D D, springs, fixed on with screws at E E; F, a bar or guide, projecting an inch to prevent the rod from running down, which, when in use, must be the farthest part of the machine from the operator, and down on it the rod must come when worked; G, a key to keep the brake in its place when erected for use, by passing the end through two staples on a strong stake, provided for the purpose; H to I, fifteen inches; H to K, twenty-one inches, the whole length. The operator is to place himself in a position so as to have a sway of the body, with the left hand on the rod, to bring it down on the guide, by which the brake will be kept clean from the rind, &c. without further trouble. The chief point in making these brakes is, to make sure of the strength and elasticity of the springs.



**WINCH**, a cylindrical piece of timber, having an axis, whose extremities rest in two channels placed horizontally or perpendicularly, and furnished with clicks or pauls. It is turned about by means of a handle resembling that of a grindstone, and is generally employed as a purchase, by which a rope or tackle-fall may be more powerfully applied to any object than when used singly, or without the assistance of mechanical powers.

Winch, is also the name of certain long iron handles by which the chain-pumps are worked.

**WIND**, a sensible current in the atmosphere. The motions of the atmosphere are subject in some degree to the same laws as those of the denser fluids; if we remove a portion of water in a large reservoir, we see the surrounding water flow in to restore the equilibrium; and if we impel in any direction a certain portion, an equal quantity moves in a contrary direction, from the same cause; or if a portion, being rarefied by heat or condensed by cold, ascends in the one instance and descends in the other, a counter-current is the visible and natural result; and similar effects are found to follow the same causes in the atmospheric fluid. Thus, no wind can blow without a counter or opposite current, nor can any wind arise, without a previous derangement of the general equilibrium; the general causes of which may be stated as follows:

1. The ascent of the air over certain tracts heated by the sun. 2. Evaporation causing an actual increase in the volume of the atmosphere. 3. Rain, snow, &c. causing an actual decrease in its volume by the destruction of the vapour. Currents thus produced may be permanent and general, extending over a large portion of the globe: periodical, as in the Indian ocean; or variable, and as it were occasional, or at least uncertain, as the winds in temperate climates. General or permanent winds blow always nearly in the same direction. In the Atlantic and Pacific oceans, under the equator, the wind is almost always easterly; it blows, indeed, in this direction on both sides of the equator to the latitude of 28°. More to the northward of the equator, the wind generally blows between the north and east; and the farther north we proceed, we find the wind to blow to a more northern direction; more to the southward of the equator, it blows between the south and east; and the farther to the south, the more it comes in that direction. Between the parallels of 28° and 40° south latitude, in that tract which extends from 30° west to 100° east longitude from London, the wind is variable, but it most frequently blows from between the N.W. and S.W. so that the outward bound East-India ships generally run down their easting on the parallel of 36° south. Navigators have given the appellation of trade-winds to these general winds

*Periodical* Winds.—Those winds which blow in a certain direction for a time, and at certain stated seasons change, and blow for an equal space of time from the opposite point of the compass, are called monsoons. During the months of April, May, June, July, August, and September, the wind blows from southward over the whole length of the Indian ocean, *viz.* between the parallels of 28° N. and 28° S. latitude, and between the eastern coast of Africa and the meridian which passes through the western part of Japan; but in the other months, October, November, December, January, February, and March, the winds in all the northern parts of the Indian ocean shift round, and blow directly contrary to the course they held in the former six months. For some days before and after the change, there are calms, variable winds, and tremendous storms with thunder, &c.

*Causes of the* Wind.—Philosophers differ in their opinions respecting the cause of these periodical winds; but a more probable theory of the general trade-winds is, that they are occasioned by the heat of the sun in the regions about the equator, where the air is heated to a greater degree, and consequently rarefied more, than in the more northern parts of the globe. From this expansion of the air in these tropical regions, the denser air in higher latitudes rushes violently towards the equator from both sides of the globe. By this conflux of the denser air, without any other circumstances intervening, a direct northerly wind would be produced in the northern tropic, and a southern one in the other tropic; but as the earth's diurnal motion varies the direct influence of the sun over the surface of the earth, and as by that motion this influence is communicated from east to west, an easterly wind would be produced if this influence alone prevailed. On account of the co-operation of these two causes at the same time, the trade-winds blow naturally from the N. E on the north, and from the S. E on the south of the line, throughout the whole year; but as the sun approaches nearer the tropic of Cancer in our summer season, the point towards which these winds are directed will not be invariably the same, but they will incline more towards the north in that season, and more towards the south in our winter.

The land and sea breezes in the tropical climates may be considered as partial interruptions of the general trade-winds; and the cause of these it is not very difficult to explain. From water being a better conductor of heat than earth, the water is always of a more even temperature. During the day, therefore, the land becomes considerably heated, the air rarefied, and consequently in the afternoon a breeze sets in from the sea, which is less heated at that time than the land. On the other hand, during the night the earth loses its surplus heat, while the sea continues more even in its temperature. Towards morning, therefore, a breeze regularly proceeds from the land towards the ocean, where the air is warmer, and consequently more rarefied, than on shore.

The cause of the monsoons is not so well understood as that of the general trade-winds; but what has been just remarked suggests, at least, a probable theory on the subject. It is well known, that at the equator the changes of heat and cold are occasioned by the diurnal motion of the earth, and that the difference between the heat of the day and the night is almost all that is perceived in those tropical regions: whereas in the polar regions the great vicissitudes of heat and cold are occasioned by the annual motion of the globe, which produces the sensible changes of winter and summer; consequently, if the heat of the sun was the only cause of the variation of the winds, the changes, if any, that would be produced by those means in equatorial regions, ought to be diurnal only, but the changes about the pole should be experienced only once in six months. As the effects arising from the heat of the sun upon the air must be greater at the equator than at the poles, the changes of the wind arising from the expansion of the air by the sun's rays must be more steady in equatorial than in polar regions. The incontrovertible evidence of navigators proves this truth, that winds are more variable towards the poles, and more constant towards the equator. But in summer, the continual heat, even in high latitudes, comes to be sensibly felt, and produces changes on the wind, which are distinctly perceptible. In our own cold region the effects of the sun on the wind are felt during the summer months; for while the weather in that season of the year is fine, the wind generally becomes stronger as the time of the day advances, and dies away towards the evening, and assumes that pleasing serenity so delightful to our feelings. Such are the diurnal changes of the wind in northern climates. The annual revolution of the sun produces still more sensible effects. The prevalence of the western winds during summer we may attribute to this cause, which is still more perceptible in France and Spain, because the continent of land to the eastward, being heated more than the waters of the Atlantic ocean, the air is drawn during that season towards the east, and consequently produces a western wind. But these effects are much more perceptible in countries near the tropics than with us. For when the sun approaches the tropic of Cancer, the soil of Persia, Bengal, China, and the adjoining countries, becomes so much more heated than the sea to the southward of those countries, that the current of the general trade-wind is interrupted, so as to blow at that season from the south to the north, contrary to what it would do if no land was there. But as the high mountains of Africa during all the year are extremely cold, the low countries of India, to the eastward of it, become hotter than Africa in summer, and the air is naturally drawn thence to the eastward. From the same cause it follows that the trade-wind in the Indian ocean, from April till October, blows in a north-east direction, contrary to that of the general trade-wind in open seas in the same latitude; but when the sun retires towards the tropic of Capricorn, these northern parts become cooler, and the general trade-wind assumes its natural direction.

Having given the most obvious causes of the periodical monsoons in the Indian seas, it is necessary to observe, that no monsoon takes place to the southward of the equator, except in that part of the ocean adjoining to New Holland. There the same causes concur to produce a monsoon, as in the northern tropic, and similar appearances take place. From October till April, the monsoons set in from the N. W. to S. E. opposite to the general course of the trade-wind on the other side of the line: and here also the general trade-wind resumes its usual course during the other months, which constitute the winter season in these regions. It may not be improper to conclude this account of the tropical winds, by enumerating some of the principal inflections of the monsoons.

Between the months of April and October the winds blow constantly from W.S.W. in all that part of the Indian ocean which lies between Madagascar and Cape Comorin, and in the contrary direction from October till April, with some small variation in different places, but in the Bay of Bengal these winds are neither so strong nor so constant as in the Indian ocean. It must also be remarked, that the S.W. winds in those seas are more southerly on the African side, and more westerly on the side of India; but these variations are not so great as to be repugnant to the general theory. The cause of this variation is, as was before intimated, that the mountainous lands of Africa are colder than the flatter regions of Arabia and India; consequently the wind naturally blows from these cold mountains, in the summer season, towards the warmer lands of Asia, which occasions those inflections of the wind to the eastward during the summer months. The peninsula of India lying so much farther to the south than the kingdoms of Arabia and Persia, adds greatly to this effect; because the wind naturally draws towards them, and produces that easterly variation of the monsoon which takes place in this part of the ocean, while the sandy deserts of Arabia draw the winds more directly northward near the African coast. A similar chain of reasoning will serve to explain any other inflections or variations that may occur in the perusal of books of travel, &c.

*Variable* WINDS.—In the temperate zones the direction of the winds is by no means so regular as between the tropics. Even in the same degree of latitude, we find them often blowing in different directions at the same time; while their changes are frequently so sudden and so capricious, that to account for them has hitherto been found impossible. When winds are violent, and continue long, they generally extend over a large tract of country, and this is more certainly the case when they blow from the north or east than from any other points. By the multiplication and comparison of meteorological tables, some regular connexion between the changes of the atmosphere in different places may, in time, be observed, which may at last lead to a satisfactory theory of the winds. It is from such tables chiefly, that the following facts have been collected.

In Virginia, the prevailing winds are between the south-west, west, north, and north-west; the most frequent is the south-west, which blows more constantly in June, July, and August, than at any other season. The north-west winds blow most constantly in November, January, and February. At Ipswich in New England, the prevailing winds are also between the south-west, west, north, and north-east; the most frequent is the north-west. But at Cambridge, in the same province, the most frequent wind is the south-east. The predominant winds at New York are the north and west; and in Nova Scotia north-west winds blow for three-fourths of the year. The same wind blows most frequently at Montreal in Canada; but at Quebec the wind generally follows the direction of the river St. Lawrence, blowing either from the north-east or south-west. At Hudson's Bay, westerly winds blow for three-fourths of the year; the north-west wind occasions the greatest cold, but the north and north-east are the vehicles of snow.

It appears from these facts that westerly winds are most frequent over the whole eastern coast of North America; that in the southern provinces, south-west winds predominate; and that the north-west become gradually more frequent as we approach the frigid zone.

In Egypt, during part of May, and during June, July, August, and September, the wind blows almost constantly from the north, varying sometimes in June to the west, and in July to the west and the east; during part of September, and in October and November, the winds are variable, but blow more regularly from the east than any other quarter; in December, January, and February, they blow from the north, north-west, and west; towards the end of February they change to the south, in which quarter they continue till near the end of March; during the last days of March, and in April, they blow from the south-east, south, and south-west, and at last from the east; and in this direction they continue during a part of May. In the Mediterranean the wind blows nearly three-fourths of the year from the north; about the equinoxes there is always an easterly wind in that sea, which is generally more constant in spring than in autumn. These observations do not apply to the gut of Gibraltar, where there are seldom any winds except the east and west. At Bastia, in the island of Corsica, the prevailing wind is the south-west. In Syria the north wind blows from the autumnal equinox to November; during December, January, and February, the winds blow from the west and south-west, in March they blow from the south, in May from the east, and in June from the north. From this month to the autumnal equinox, the wind changes gradually as the sun approaches the equator, first to the east, then to the south, and lastly to the west. At Bagdad the most frequent winds are the south-west and north-west; at Pekin the north and the south; at Kamtschatka, on the north-east coast of Asia, the prevailing winds blow from the west.

In Italy the prevailing winds differ considerably, according to the situation of the places where the observations have been made; at Rome and Padua they are northerly, at Milan easterly. All that we have been able to learn concerning Spain and Portugal is, that on the west coast of these countries, the west is by far the most common wind, particularly in summer; and that at Madrid the wind is north-east for the greatest part of the summer, blowing almost constantly from the Pyrenean mountains. At Berne in Switzerland, the prevailing winds are the north and west; at St. Gothard the north-east; at Lausanne the north-west and south-west.

Father Cotte has given us the result of observations made at 86 different places of France; from which it appears, that along the whole south coast of that kingdom the wind blows most frequently from the north, north-west, and north-east; on the west coast, from the west, south-west and north-west; and on the north coast from the south-west. That in the interior parts of France, the south-west wind blows most frequently in 18 places; the west wind in 14; the north in 13; the south in 6; the north-east in 4; the south-east in 2; the east and north-west each of them one. On the west coast of the Netherlands, as far as Rotterdam, the prevailing winds are probably the south west, at least this is the case at Dunkirk and Rotterdam. It is probable also, that along the rest of the coast, from the Hague to Hamburgh, the prevailing winds are the north-west, at least these winds are most frequent at the Hague and at Franeker. The prevailing wind at Delft is the south-east; and at Breda, the north and the east.

In Germany, the east wind is most frequent at Gottingen, Munich, Weissenfels, Dusseldorf, Saganum, Erford, and at Buda in Hungary; the south-east at Prague and Wurtzburg; the north-east at Ratisbon; and the west at Manheim and Berlin. From an average of ten years of the register kept by order of the Royal Society, it appears that at London the winds blow in the following order:

| Winds. | Days. | Winds. | Days. |
|---|---|---|---|
| South-west, ......... | 112 | South-east, .......... | 32 |
| North-east, .......... | 58 | East, ................ | 26 |
| North-west, ......... | 50 | South, ............... | 18 |
| West, .............. | 53 | North, ............... | 16 |

It appears, from the same register, that the south-west wind blows at an average more frequently than any other wind during every month of the year, and that it blows longest in July and August; that the north-east blows most constantly during January, March, April, May, and June, and most seldom during February, July, September, and December: and that the north-west wind blows oftener from November to March, and more seldom during September and October than any other winds. The south-west winds are also most frequent at Bristol, and next to them are the north-east.

The following table of the winds at Lancaster has been drawn up from a register kept for seven years at that place.

| Winds. | Days. | Winds. | Days. |
|---|---|---|---|
| South-west, ......... | 92 | South-east, ......... | 35 |
| North-east, .......... | 67 | North, ... .......... | 30 |
| South, .............. | 51 | North-west, .......... | 26 |
| West, ..... ........ | 41 | East, ................ | 17 |

The following table is an abstract of nine years' observations made at Dumfries by Mr. Copland:

| Winds. | Days. | Winds. | Days. |
|---|---|---|---|
| South, .............. | 82½ | North, .............. | 36½ |
| West, .............. | 69 | North-west, ........ | 25½ |
| East, .............. | 68 | South-east, ......... | 28½ |
| South-west, ........ | 50½ | North-east, ......... | 14½ |

The following table is an abstract of seven years' observations made by Dr. Meek at Cambuslang, near Glasgow:

| Winds. | Days. | Winds. | Days. |
|---|---|---|---|
| South-west, ........ | 174 | North-east, ......... | 104 |
| North-west, ........ | 40 | South-east, ......... | 47 |

It appears from the register from which this table was extracted, that the north-east wind blows much more frequently in April, May, and June, and the south-west in July, August, and September, than at any other period. The south-west is by far the most frequent wind all over Scotland, especially on the west coast. At Saltcoats, in Aryshire, for instance, it blows three-fourths of the year; and along the whole coast of Murray, on the north-east side of Scotland, it blows for two-thirds of the year. East winds are common over all Great Britain during April and May; but their influence is felt most severely on the eastern coast.

The following table exhibits a view of the number of days during which the westerly and easterly winds blow in a year at different parts of the island. Under the term westerly are included the north-west, west, south-west, and south; the term easterly is taken in the same latitude.

| Years of Observation. | Places. | Wind. | |
|---|---|---|---|
| | | Westerly. | Easterly. |
| 10 | London,...................... | 233 | 132 |
| 7 | Lancaster, .................. | 216 | 149 |
| 51 | Liverpool, .................. | 190 | 175 |
| 9 | Dumfries, ................... | 227·5 | 137·5 |
| 10 | Branxholm, 54 miles south-west of Berwick, ........ | 232 | 133 |
| 7 | Cambuslang, ................. | 214 | 151 |
| 8 | Hawkhill, near Edinburgh,.... | 229·5 | 135·5 |
| | Mean.... | 220·3 | 144·7 |

In Ireland the south-west and west are the grand trade-winds, blowing most in summer, autumn, and winter, and least in spring. The north-east blows most in spring, and nearly double to what it does in autumn and winter. The south-east and north-west are nearly equal, and are most frequent, after the south-west and west.

At Copenhagen the prevailing winds are the east and south-east; at Stockholm, the west and north. In Russia, from an average of a register of 16 years, the winds blow from November to April in the following order:

| | W. | N.W. | E. | S.W. | S. | N.E. | N. | S.E. |
|---|---|---|---|---|---|---|---|---|
| Days | 45 | 26 | 23 | 22 | 20 | 19 | 14 | 13 |

and during the other six months,

| | W. | N.W. | E. | S.W. | S. | N.E. | N. | S.E. |
|---|---|---|---|---|---|---|---|---|
| Days | 27 | 27 | 19 | 24 | 22 | 15 | 32 | 18 |

The west wind blows during the whole year 72 days; the north-west 58; the south-west and north 46 days each. During summer it is calm for 41 days, and during winter for 21. In Norway, the most frequent winds are the south, the south-west, and the south-east. The wind at Bergen is seldom directly west, but generally south-west or south-east; a north-west, and especially a north-east wind, are but little known there. From the whole of these facts, it appears that the most frequent winds on the south coasts of Europe, are the north, the north-east, and north-west, and on the western coast the south-west: that in the interior parts, which lie more contiguous to the Atlantic ocean, south-west winds are also most frequent; but that easterly winds prevail in Germany. Westerly winds are also more frequent on the north-east coast of Asia. It is probable that the winds are more constant in the south temperate zone, which is in a great measure covered with water, than in the north temperate zone, where their direction must be frequently interrupted and altered by mountains and other causes.

M. De la Caille, who was sent thither by the French king to make astronomical observations, informs us, that at the Cape of Good Hope the principal winds are the south-east and north-west; that other winds seldom last longer than a few days; and that the east and north-east winds blow very seldom. The south-east wind blows in most months of the year, but chiefly from October to April; the north-west prevails during the other six months, bringing along with it rain, and tempests, and hurricanes. Between the Cape of Good Hope and New Holland, the winds are commonly westerly, and blow in the following order: north-west, south-west, west, north.

In the Great South Sea, from latitude 30° to 40° south, the south-east trade-wind blows most frequently, especially when the sun approaches the tropic of Capricorn; the wind next to it in frequency is the north-west, and next to that is the south-west. From south latitude 40° to 50°, the prevailing wind is the north-west, and next the south-west. From 80° to 60°, the most frequent wind is also the north-west, and next to it is the west. Thus it appears that the trade-winds sometimes extend farther into the south temperate zone than their usual limits, purticularly during summer; that beyond their influence the winds are commonly westerly, and that they blow in the following order: north-west, south-west, west. Such is the present state of the history of the direction of the winds. In the torrid zone they blow constantly from the north-east on the north side of the equator, and from the south-east on the south side of it. In the north temperate zone they blow most frequently from the south-west; in the south temperate zone from the north-west, changing, however, frequently to all points of the compass; and in the north temperate zone blowing particularly, during spring, from the north-east.

*Force and Velocity of the Wind.*—As to the velocity of the wind, its variations are almost infinite; from the gentlest breeze to the hurricane which tears up trees and blows down houses. It has been remarked that our most violent winds take place when neither the heat nor the cold is greatest; that violent winds generally extend over a great tract of country, and that they are accompanied by sudden and great falls in the mercury of the barometer. The reason appears to be, that violent winds succeed the precipitation in rain of a large quantity of vapour, which previously constituted a part of the bulk of the atmosphere; and this precipitation cannot take place when the general temperature approaches to either extreme. The wind is sometimes very violent at a distance from the earth, while it is quite calm at its surface. On one occasion Lunardi went at the rate of 70 miles an hour in his balloon, though it was quite calm at Edinburgh when he ascended, and continued so during his whole voyage. The same thing happened to Garnerin and his companion in their aerostatic voyage to Colchester; they having been carried from London to Colchester, a distance of at least 60 miles, in three quarters of an hour, making the velocity of the wind, at that time, 80 miles per hour, or 1⅓ mile per minute. This again may be illustrated by the motions of dense fluids, which are always impeded in the parts contiguous to the sides and bottoms of the vessels; and the same thing happens in tide rivers, where the boatman, when he wishes to proceed with the tide, commits himself to the middle of the stream; but when he has to strive against it, he keeps close to the shore. It is, therefore, not the upper parts of the atmosphere which are accelerated, but the lower are retarded by friction against the surface of the earth.

The following table, drawn up by Mr. Smeaton, will give the reader a pretty precise idea of the velocity of the wind in different circumstances:

| Miles per Hour. | Feet per Second. | Perpendicular Force on one square Foot, in Avoirdupois Pounds and Parts. | |
|---|---|---|---|
| 1 | 1·47 | ·005 | Hardly perceptible. |
| 2 | 2·93 | ·020 | Just perceptible. |
| 3 | 4·4 | ·044 | |
| 4 | 5·87 | ·079 | Gently pleasant. |
| 5 | 7·33 | ·123 | |
| 10 | 14 67 | ·492 | Pleasant, brisk. |
| 15 | 22· | 1·107 | |
| 20 | 29 34 | 1·968 | Very brisk. |
| 25 | 36·67 | 3·075 | |
| 30 | 44·01 | 4·429 | High wind |
| 35 | 51·34 | 6·027 | |
| 40 | 58 68 | 7·873 | Very high wind. |
| 45 | 66·01 | 9·963 | |
| 50 | 73·35 | 12·300 | Storm or tempest. |
| 60 | 88 02 | 17·715 | Great storm. |
| 80 | 117·36 | 31·490 | Hurricane. |
| 100 | 146 7 | 49·200 | Hurricane that tears up trees, and carries buildings before it. |

**Wind**-*Gage*. *See* Anemometer, where the velocity of the wind is fully treated of.

**Wind**, with regard to a ship's course, is termed a foul wind, or a fair wind, a scant wind or a leading wind: these terms being respectively opposed to each other.

**Wind's** *Eye*, implies the direct point from which the wind blows.

*Between Wind and Water*, signifies that part of a ship's bottom which is frequently brought above the water by her agitation when at sea.

**Wind** *Sails*, in a ship, are made of the common sail-cloth, and are usually between 25 and 30 feet long, according to the size of the ship, and are in the form of a cone ending obtusely.

**WINDAGE**, the difference between the diameter of a piece of artillery, and the diameter of the shot or shell corresponding thereto.

**WINDING a Call**, the act of blowing or piping on a boatswain's whistle, so as to communicate the necessary orders of hoisting, heaving, belaying, veering away, &c.

**Winding** *Tackle*, a name usually given to a tackle, formed of one fixed triple block, and one double or triple moveable block. It is principally employed to hoist up any weighty materials, such as the cannon, into or out of a ship.

**WINDLASS**, a machine used in merchant ships instead of a capstan, to heave up the anchors from the bottom, &c. It is a large cylindrical piece of timber, moving round on its axis in a vertical position, and is supported at its two ends by two pieces of wood, called knight-heads, which are placed on the opposite sides of the deck near the fore-mast; it is turned about by levers, called handspikes, which are for this purpose thrust into holes bored through the body of the machine. The lower part of the windlass is usually about a foot above the deck. It is, like the capstan, furnished with strong pauls, to prevent it from turning backwards by the effort of the cable, when charged with the weight of the anchor, or strained by the violent jerking of the ship in a tempestuous sea. The pauls, which are formed of wood or iron, fall into notches cut in the surface of the windlass, and lined with plates of iron. Each of the pauls being accordingly hung over a particular part of the windlass, falls eight times into the notches at every revolution of the machine; because their eight notches are placed on its circumference under the pauls: so, if the windlass is twenty inches in diameter, and purchases five feet of the cable at every revolution, it will be prevented from turning back, or losing any part thereof, at every seven inches, nearly, which is heaved in upon its surface. As this machine is heaved about in a vertical direction, it is evident that the effort of an equal number of men acting upon it will be much more powerful that on the capstan; because their whole weight and strength are applied more readily to the end of the lever employed to turn it about; whereas, in the horizontal movement of the capstan, the exertion of their force is considerably diminished. It requires, however, some dexterity and address to manage the handspike to the greatest advantage; and to perform this, the sailors must all rise at once upon the windlass, and, fixing their bars therein, give a sudden jerk at the same instant, in which movement they are regulated by a sort of song or howl pronounced by one of their number.

*Spanish* **Windlass**, is a machine formed of a handspike and a small lever, usually a tree-nail, to set up the top-gallant rigging, or for any other short steady purchase.

**WINDMILL.** *See* Mill.

**WIND-RODE**, is a term applied to a ship, which, riding where the wind and tide are opposed to each other, is forced by the violence of the former to remain to leeward of her anchor.

**WIND-SAIL**, a sort of wide tube or funnel of canvass, employed to convey a stream of fresh water downwards into the lower apartments of a ship, being let down through the hatches, and kept extended by means of several wooden hoops; the upper part is open on one side, which is braced to the wind so as to receive the full current of it, which fills the tube, and rushes downward into the lower regions of the ship. Ships of war have generally, in hot climates, three or four of these windsails, for the preservation of the crew's health.

**WINE.** All wines contain an acid, alcohol, tartar, extract, aroma, and colouring matter. The presence and nature of each of these principles may be ascertained in the following way: 1. Acid. All wines, even the softest and mildest, redden litmus, and therefore contain an acid. This abounds, however, chiefly in the thin wines of wet and cold climates, where the grape juice or must contains but a small portion of sugar. When wine has been boiled to extract the brandy, the liquor which remains in the still, and is thrown away as useless, is a sour nauseous fluid with an acrid and burnt flavour. When filtered, and allowed to remain at rest for a time, it deposits a good deal of extractive matter, becomes covered with mould, and then contains a notable quantity of acetous acid, which may be separated by distillation. The acid is however not entirely acetous, at least not till after standing a considerable time, for it precipitates and forms an insoluble salt with lime water, and with the insoluble salts of silver, lead, and mercury, appears to be the malic acid mixed with a little citric, both of which are converted into vinegar by spontaneous decomposition. The wines that contain the greatest quantity of these acids yield the worst brandy, nor is there any method yet known of separating or neutralizing the acid without materially injuring the quality, or lessening the quantity of the ardent spirit. 2. Alcohol. The existence of this principle, and mode of extraction by distillation, has been described under the article Distillation. The quantity of alcohol varies prodigiously. The strong, rich, full-bodied wines of the warmer wine countries will yield as much as a third of ardent spirit; whilst the thin light wines will often give no more than about one sixteenth of the same strength. 3. Tartar. This substance has also been fully described in its proper place. Tartar is not altogether a product of the fermentation of wine, since it is contained in must, though in small quantity. 4. Extract. Must contains an abundance of extractive matter, which materially assists the fermentation, and is afterwards found, in part at least, in the lees, but another portion may be obtained from the wine by evaporation. It is also extract that mixes with and colours the tartar. By age the quantity of extractive matter diminishes. 5. Aroma. All wines possess a peculiar and grateful smell, which would indicate a distinct aromatic principle, but it has never been exhibited in the form of essential oil, or condensed in any smaller quantity by distillation or any other mode. To give wine all its aroma, it should be fermented very slowly. 6. Colouring matter. The husk of the red grape contains a good colour, which is extracted when the entire fruit is pressed, and becomes dissolved in the wine when the fermentation is complete. Many substances will separate the colour. If lime water is added to high-coloured wine, a precipitate is formed of malat of lime, that carries down with it all the colouring matter, which cannot again be separated either by water or alcohol. But if wine alone is evaporated gently to dryness, and the residue treated with alcohol, the colouring matter dissolves therein. We may add, too, that the natural colour of wine is entirely and speedily destroyed by the addition of hot well-burnt charcoal in pretty fine powder. The colour of red wine, in the state in which we receive it, is not entirely that of the grape, but is given by other colouring substances, which however are quite innoxious.

WINES, *Raisin.*—These wines are made of various kinds of fruit; of Malaga's, Belvidere's, Smyrna's, raisins of the sun, &c. But the fruit that produces the best wines is black Smyrna's, their juice being the strongest, and the fruit clearest from stalks: for the stalks in Malaga's and Belvidere's are apt to give the wine a bad flavour, and will always throw an acid on it; for the stalks of all fruits are acid; but the stalks of Smyrna's are so trifling, that after rubbing the fruit between your hands they will easily sift out. Wine made from this fruit is the colour of Madeira, and has very much the flavour of it. Malaga is the colour and flavour of foreign Malaga, but not near so strong. Wine made from Belvidere's is strong and very sweet, and, after keeping it four or five years, is very little inferior to old mountain. In order to succeed in making these wines, you ought never to set the steeps in hot weather, because the heat will put the fruit in a fret, which will injure its fermenting kindly. The best time for making is in January or February. Set the steeps in the coldest part of the cellar, still remembering to keep them from the frost. To every gallon of water put five pounds of fruit, if good; if but indifferent, put six pounds into the steep. Keep stirring them three or four times a day, and let them continue in the steep till the fruit begins to burst, and the stones swim on the top; which will be in about fourteen or fifteen days. Then strain the liquor from the fruit, and press the fruit very dry, mixing the pressings with the rest of the liquor, and put all together into a cask, and ferment it in the following manner. To every pipe of wine take two quarts of solid ale yeast and one ounce of jalap, put them into a can, and into them pour a gallon of the new wine first made hot, whisk them well together, and apply to the pipe, stirring all together very well. If the cask be less than a pipe, proportion your yeast and jalap accordingly. When the ferment comes on, you must keep the bung-holes clean, and let the vessel be filled up three or four times a day. Let it ferment ten or twelve days, or till it works clean and white. Then take it off its bottom, which will be very considerable, and put it into a clean cask. You may filter the bottom through a linen rag, and put to the wine. Lay some heavy weight over the bung, and let it stand a day. Then lay on the top of the wine five gallons of molasses spirit, and bung it up close. Leave out the vent-peg a day or two; then drop it in the hole, and close it by degrees till you have made it quite close. Let it lie in this state for six months, at that time rack it from its bottom into a clean pipe, and you will find it tolerably fine. Then put to it one quart of forcing, and bung it up. Let it lie till within a month of your wanting it; for the longer it lies, the better it will be in body. Then rack it for the last time, (always observing you touch no bottoms,) and put three pints of forcing to it. Stir it well with a paddle, and bung it up. The bottoms you may run through a linen rag as before, and mix with that in the pipe. You may pierce the wine in six or seven days, and you will find it quite fine and bright.

*To force Raisin Wines.*—For one pipe take two quarts of good cider; put half an ounce of ground alum to it, and one ounce of isinglass pulled to small pieces. Beat them well in your can three or four times a day, and let the mixture stand till it becomes a stiff jelly; then break it with your whisk, and add to it two pounds of white sand or stone dust. Then break it up gradually with some of the wine, till you have made the two quarts two gallons; stir it well together, and apply it to the pipe, and bung up close. The sand will carry down with it all the small particles which the isinglass misses, and likewise confine the bottom so as to prevent it from rising. But if you make the wine stronger by allowing a larger quantity of fruit to the gallon, this forcing will not do; for all forcings must be stronger than the body forced, or else the foul parts will not fall; therefore such wines must be forced with English stum, a quart of which is sufficient for a pipe, one pound of alabaster being beat in with it, and applied as above.

*English Stum.*—Take a five-gallon cask that has been well soaked in water, set it to drain. Then take a pound of roll brimstone, and melt it in a ladle; put as many rags to it as will suck up the melted brimstone. Burn half those rags in the cask, covering the bung-hole so much as that it may have just air enough to keep it burning. When burnt out, put three gallons of very strong cider, and one ounce of common alum (pounded and mixt with the cider) into the cask. Keep rolling the cask about five or six times a day for two days. Then take out the bung, and hang the remainder of the rags on a wire in the cask, as near the cider as possible, and set them on fire as before. When burnt out, bung the cask close, and roll it well about three or four times a day for two days; then let it stand seven or eight days, and this liquor will be so strong as to affect your eyes by looking at it. When you force a pipe, take one quart of this liquid, put half an ounce of isinglass to it, beat and pulled to small pieces. Whisk it together, and it will dissolve in four or five hours. Break the jelly with a whisk, and put one pound of alabaster to it, then dilute it with some of the wine, put it in the pipe, bung it close, and in a day it will be fine and bright.

*To cure Acid Raisin Wines.* The following ingredients must be proportioned to the degree of acidity: if but small, you must use the less; if a stronger acid, a larger quantity. It must likewise be proportioned to the quantity of wine, as well as to the degree of acidity. Observe, that the cask be nearly full before you apply the ingredients; which will have this good effect, the acid part of the wine will rise to the top immediately, and issue out at the bung-hole. But if the cask be not full, the part that should fly off will still continue in the cask, and weaken the body of the wine. If the cask be full, it will be fit to have a body laid on it in three or four days' time. We shall here proportion the ingredients for a pipe, supposing it quite acid, so as but just recoverable. Take two gallons of lac, and two ounces of isinglass, boil them a quarter of an hour; strain the liquor, and let it stand till it is cold; then break it well with your whisk, and put four pounds of alabaster and three pounds of whiting to it. Stir them well together, and add one ounce of salt of tartar to the whole. Mix by degrees some of the wine with it, so as to dilute it to a thin liquor. Apply this to the cask, and stir it well with your paddle. This will immediately discharge the acid part from it, as was said before. —When it is off, and quite down, bung it up for three days, then rack it, and you will find part of its body gone off by the strong fermentation. To remedy this, you must lay a fresh body on it in proportion to the degree to which it has been lowered by the above process; always having especial care not to alter the flavour. And this must be done with clarified sugar; for no fluid body will agree with it but what will make it thinner, or confer its own taste; therefore the following is the best manner.

*To lay a fresh Body on the Wines.*—Take three-quarters of a hundred weight of brown sugar, and put into your copper, then put a gallon of lime water to it, to keep it from burning. Keep stirring it about till it boils; then take three eggs, and mash all together with the shells, which put to the sugar. Stir it about; and as the scum or filth arises, take it off. When quite clean, put it into your can, and let it stand till it is cold before you use it. Then break it with the whisk by degrees, with about ten gallons of wine, and apply it to the pipe. Work it with your paddle for half an hour; then put one quart of stum forcing to it, which will unite their bodies, and likewise make it fine and bright. You must keep it bunged very close.

*To cure Raisin Wines that are cloudy.*—These wines, if they take a chill, are affected in the same manner with port wines. Like them they will be cloudy, and will have a floating lee in them, which by shaking in a glass will rise in clouds. If any thing be applied to it cold, it will strike a greater chill upon it, and change its true colour to a pale or deep blue one; to prevent which, and take off the chill, you must,

*For a Pipe.*—Take one gallon of lac, and one ounce of isinglass broken in small pieces, three pounds of alabaster, two ounces of sweet spirit of nitre; boil them together for five or six minutes; stir them, and apply to the pipe as hot as possible. Stir it well in the pipe with your paddle, and in about two hours after bung it close up. Let it lie five or six days, and you will find it quite fine and bright. This will make it a little flat; to remedy which, you must rack it clean from its bottoms, and throw a quart of stum forcing to it.

*To colour Raisin Wines.*—Wine made of raisins of the sun is always of the colour of Rhenish, which is almost white. Very often that which is made of Malaga's (especially if the fruit be but indifferent) will not hold its colour, but must have a colour laid on it. The right colour of raisin wine is the colour of mountain. You must take care that your wine has not a great bottom in it; for if it has, it will be longer before it falls fine. In order to lay a mountain colour on your wine, you must take three or four pounds of brown sugar, according to the quantity of wine you want to colour. Put it in an iron pan or iron ladle, set it over the fire, and keep stirring it about. Let it burn in this manner till it is quite black and bitter, which will be about half an hour. If you burn one pound of sugar, put a quart of boiling hot water to it; stir it about, and let it boil a quarter of an hour longer, then take it off and let it cool. A pint of this mixture is sufficient to colour a pipe of wine; but note, that with every pint you must mix a quarter of an ounce of common alum pounded to a fine powder; which will set the colour so that it will not subside, otherwise it will fall to the bottom, and have no good effect on the liquor. If you would have your wine of the colour of port, you must take eight ounces of logwood raspings, four ounces of alkanet root, and one ounce of cochineal. Infuse them over a slow fire for three hours, strain the liquor from the wood, and keep it boiling. Then burn three pounds of brown sugar as before, and put the coloured liquor to it; boil all together a quarter of an hour longer; then take it off, and when cold bottle it for use. A pint of this liquor will make a pipe the colour of port wine. You must always remember to set the colour with a quarter of an ounce of common alum, ground or beaten to a fine powder.

*Wine from Apples.*—The Danish chemist, Oersted, has demonstrated, that, of all the fruits which grow in Denmark, the apple, mixed with a great quantity of sugar, produces a drink which more nearly resembles wine than any other substitute. Cherries, gooseberries, and other fruits, from which a vinous liquor is extracted, are not so proper for it. He hopes, before many years, to make very good wine with apple juice and sugar.

**WINGERS**, small casks stowed close to the side in a ship's hold, where the large casks would cause too great a rising in that part of the tier.

**WINGS**, a name given to those parts of the hold and orlop-deck which are nearest to the sides. This term is particularly used in the stowage of the several materials contained in the hold.

**Wings**, are also the skirts or extremities of a fleet, when ranged in a line abreast, or when forming two sides of a triangle. It is usual to extend the wings of a fleet in the day-time, in order to discover any enemy that may fall in their track; they are, however, commonly summoned by signal to draw nearer to the centre of the squadron before night.

**WINNOWING MACHINES.** Machines of this sort are in pretty general use where thrashing mills, to which they may be attached, are not erected; they are made on different principles, according to particular circumstances.

**WIRE DRAWING**, is the art of drawing out long bars of metal, by pulling it through holes in a plate of steel, or other fit metallic compound. In order that a wire may be drawn, it is requisite that the metal should have considerable tenacity. Gold, siver, iron, steel, copper, and their compounds, are most commonly used in the arts. The process is of considerable simplicity.—A number of holes, progressively smaller and smaller, are made in a plate of steel, and the pointed end of a bar of metal being passed through one end of them, is forcibly drawn by strong pinchers, so as to elongate it by the pressure arising from the re-action of the greatest hole. This is the wire; and it is again passed in like manner through another hole, a little smaller; and by continuing the process, the wire has its length increased and its diameter diminished to a very great degree. The largest wire may be nearly an inch in diameter, and the smallest ever made was about the one-thousandth part of an inch: but it is said that silver wire has been made one-fifteen-hundredth of an inch in diameter. The size of these small wires may be ascertained from the weight of a known measure, of length and the specific gravity of the metal; or, less correctly, the wire may be wound round a pin, and the number of turns counted to make a given length. Wires are drawn square, and of other figures in their sector. In particular, they are drawn grooved, so that any small part will form the pinion of a watch or clock-work. As the violent action of the drawing-plate renders the wire hard and brittle, it is necessary to anneal it several times during the course of drawing. Very small holes are made by hammering up the larger, and the point, in very thin wire, by rolling or crushing the end by a smooth burnishing tool, upon a polished plate. Gold and silver wire is made of cylindrical ingots of silver, covered over with a skin of gold, and thus drawn successively through a vast number of holes, each smaller and smaller, till at last it is brought to a fineness exceeding that of a hair. That admirable ductility which makes one of the distinguishing characters of gold, is no where more conspicuous than in this gilt wire. A cylinder of 48 ounces of silver, covered with a coat of gold only weighing one ounce, as Dr. Halley informs us, is usually drawn into a wire, two yards of which weigh no more than one grain; whence, 98 yards of the wire weigh no more than 49 grains; and one single grain of gold covers the 98 yards; so that the thousandth part of a grain is above one-eighth of an inch long. He also, on computing the thickness of the skin of gold, found it to be $\frac{1}{282000}$ part of an inch. Yet so perfectly does it cover the silver, that even a microcope does not discover any appearance of the silver underneath. Mr. Rohault likewise observes, that a like cylinder of silver, covered with gold 2 feet 8 inches long and 2 inches 9 lines in circumference, is drawn into a wire 307,200 feet long,—115,200 times its former length. M. Boyle relates, that eight grains of gold covering a cylinder of silver, are commonly drawn into a wire 13,000 feet long. Silver wire is the same with gold wire, except that the latter is gilt, or covered with gold, and the other is not. There are also counterfeit gold and silver wires,—the first made of a cylinder of copper silvered over, and then covered with gold, and the second a cylinder of copper silvered over and drawn through iron in the same manner as gold and silver wire. Brass wire is made in the same way.

**WIT**, a faculty of the mind, consisting, according to Mr. Locke, in the assembling and putting together of those ideas, with quickness and variety, in which any resemblance or congruity can be found, in order to form pleasant pictures and agreeable visions to the fancy. This faculty, the same author observes, is just the contrary of judgment, which consists in the separating carefully from one another, such ideas, wherein can be found the least difference, thereby to avoid being misled, by similitude and affinity, from taking one thing for another.

**WITNESS**, one who is sworn to give evidence in a cause. If a man is subpœned as a witness upon a trial, he must appear in court, on pain of 100*l.* to be forfeited to the king, and 10*l.* together with damages equivalent to the loss sustained by the want of his evidence, to the party aggrieved. But witnesses ought to have a reasonable time, that their attendance upon the court may be of as little prejudice to themselves as possible: and the court of king's bench held, that notice at two in the afternoon to attend the sitting that evening at Westminster, was too short a time. Where a witness cannot be present at a trial, he may, by consent of the plaintiff and defendant, or by rule of court, be examined upon interrogatories at the judge's chambers. No witness is bound to appear to give evidence in a cause, unless his reasonable expense is tendered him; nor need he appear till such charge is actually paid him, except he both resides and is summoned to give evidence within the bills of mortality.

**WOLFF** or **Wolfius, Christian**, an eminent philosopher, born at Breslau, 1679. At Jena university he made a most extraordinary progress, and in 1792 he repaired to Leipsic, where he opened his lectures by a famous dissertation, called "Philosophia practica universalis methodo mathematica conscripta." This great man, whose life was devoted to advance science and virtue, died at Halle of the gout in his stomach, 1754, aged 76. His works in Latin and German are more than sixty in number, the best of which known are, A Course of Mathematics, 2 vols. 4to. A Dictionary on the Mathematics, &c.

**WOLFRAM**, an ore of tungsten, is found in different parts of Germany, in Sweden, Britain, France, and Spain; and almost constantly accompanied by ores of tin. It occurs both massive and crystallized. The primitive form of its crystals is a rectangular parallelopiped, whose length is 8.66, whose breadth is 5, and thickness 4.33. Colour brown or brownish black. Streak reddish brown. Powder stains paper with the same colour. Texture foliated. Easily separated into plates by percussion. Specific gravity from 7. to 7·3. Moderately electric by communication. Not magnetic. Infusible by the blowpipe. Forms with borax a greenish globule, and with microcosmic salt a transparent globule of a deep red.

**WOOD, Cutting in**, is used for various purposes; as for initial and figured letters, head and tail pieces of books; and even for mathematical schemes and other figures, to save the expense of engraving on copper; and for prints and stamps for papers, calicoes, linens, &c. The invention of cutting in wood, as well as that of copper, is ascribed to a goldsmith of Florence, but Albert Durer and Lucas brought both those arts to perfection. About 200 years ago, the art of cutting in wood was carried to a very great pitch, and might even vie for beauty and justness with that of engraving on copper. It has also of late years been much used, and it is convenient where numerous cheap embellishments are wanted for a work. The figure is drawn upon the wood, and all that part which is to be left white is cut away, and the rest left. A wood-engraving after printing 100,000 is as good as ever; and the expense in printing is not more than that of letter-press. *See* Strength of Materials.

*Dyeing* Wood. *General Observations.* It being necessary to say something as to the quality, nature, and texture of the wood most fit for dyeing, we shall state our remarks in the following order:—First, the wood mostly used to dye black, is pear-tree, holly, and beech, all of which will take a beautiful black; it should at the same time be observed, not to take wood which has been long cut, or aged, but as fresh as possible; we have likewise found that after the veneers have had one hour's boiling, and taken out to cool, that the colour has struck much stronger. It should likewise be noticed, that after the veneers are dyed, they should be dried in the air and not by the fire, or in a kiln of any kind; as it tends to destroy the colour. Secondly, in order to dye blue, green, red, or other colours, take clear holly; put the veneers first in a box or trough with clean water, and let them remain four or five days, changing the water once, or twice, as you find occasion; the water, acting as a purgative in the wood, will bring forth abundance of slime, &c.; let them dry about twelve hours before they are put in the dye; by observing this, you will find the colour strike quicker, and be of a brighter hue.

*Fine Black.*—Have a chair-maker's copper fixed, into which put six pounds of chip logwood, and as many veneers as it will conveniently hold without pressing too tight; fill it with water, and let it boil slowly for about three hours; then add half a pound of powdered verdigrise, half a pound of copperas, and four ounces of bruised nut galls, filling the copper up with vinegar as the water evaporates; let it boil gently two hours each day, till you find the wood to be dyed through, which according to the kind will be in more or less time.

*Fine Blue.*—Take a clean glass bottle, into which put one pound of oil of vitriol; then take four ounces of the best indigo, pounded in a mortar into small lumps; put them in a phial, (taking care to set the bottle in a basin or earthen-glazed pan, as it will ferment): after it is quite dissolved, provide an earthen or wooden vessel, so constructed that it will conveniently hold the veneers you mean to dye; fill it rather more than one third with water, into which pour as much of the vitriol and indigo (stirring it about), as will make a fine blue; which you may know by trying it with a piece of white paper or wood; put in your veneers, and let them remain till the dye has struck through. *Note.* The colour will be much better if the solution of indigo in vitriol is kept a few weeks before using it; also the best trough you can use, being either made of common stone like a stone sink, but of proper dimensions, say about four feet by eight or nine inches, which will be sufficiently large for veneers intended to be stained; or you may procure one made of artificial stone of any dimension, which will not cost so much; also you will find the colour strike better if, previous to putting your veneers into the blue dye, you boil them in plain water till completely soaked through, and let them remain for a few hours to dry partially, previous to immersing them in the dye.

*Fine Yellow.*—Take of the root of barberry four pounds, reduce it by sawing to dust, which put in a copper or brass trough, add four ounces of turmeric, to which put four gallons of water, then put in as many white holly veneers as the liquor will cover; boil them together for three hours, often turning them; when cool, add two ounces of aqua-fortis, and you will find the dye strike through much sooner.

*Bright Green.*—Proceed as in the above receipt to produce a yellow; but instead of adding aqua-fortis or the brightening liquid, add the vitriolated indigo, as much as will produce the desired colour.

*Bright Red.*—Take two pounds of genuine Brazil dust, add four gallons of water, put in as many veneers as the liquid will cover, boil them for three hours; then add two ounces of alum and two ounces of aqua-fortis, and keep it lukewarm until it has struck through.

*Purple.*—Take two pounds of chip logwood, and half a pound of Brazil dust, add four gallons of water, and after putting in your veneers, boil them well for at least three hours; then add six ounces of pearl ash and two ounces of alum, let them boil two or three hours every day, till you find the colour struck through. *Note.* The Brazil dust in this receipt is perhaps superfluous, as it only contributes to make the purple of a redder cast, for the pearl-ash does not act upon it to change it from a red to a purple.

*Orange.*—Let the veneers be dyed, by the method given, of a fine deep yellow, and while they are still wet and saturated with the dye, transfer them to the bright red dye, till you find the colour has penetrated equally throughout.

**WOODY FIBRE**, is procured from the wood, bark, leaves, or flowers of trees, by exposing them to the repeated action of boiling water, and boiling alcohol. It is the insoluble matter that remains, and is the basis of the solid organized parts of plants. There are as many varieties of woody fibres, as there are plants and organs of plants; but they are all distinguished by their fibrous texture, and their insolubility. Woody fibre burns with a yellow flame, and produces water and carbonic acid in burning. When it is distilled in close vessels, it yields a considerable residuum of charcoal. It is from woody fibre, indeed, that charcoal is procured for the purposes of life. M. Gay Lussac and Thenard have concluded from their experiments on wood of the oak, that 100 parts contain of carbon, 52·53; of oxygen, 41 78; hydrogen, 5·69.

**WOOL**, the covering of sheep. Each fleece consists of wool of several qualities and degrees of fineness, which the dealers therein take care to separate. The fineness and plenty of our wool is owing in a great measure to the short sweet grass in many of our pastures and downs: though the advantage of our sheep feeding on this grass all the year without being obliged to be shut up under cover during the winter, or to secure them from wolves at other times, contributes not a little to it.

**WOOLCOMBERS.** By 35 G. III. c. 124, all those who have served an apprenticeship to the trade of a woolcomber, or who are by law entitled to exercise the same, and also their wives and children, may set up and exercise such trade, or any other trade or business they are apt and able for, in any town or place within this kingdom, without any molestation: nor shall they be removable from such place by the poor laws.

**WOOLDING**, the act of winding a piece of rope about a mast or yard, to support it in a place where it is fished or scarfed, or when it is composed of several pieces united in one solid. *Woolding*, is also the rope employed in this service.

**WOOTZ.** The metal extracted from some kind of iron ore in the East Indies, apparently of good quality. It contains more carbon than steel and less than cast iron, but from want of skill in the management is far from homogeneous.

**WORD, Watch**, is a peculiar word that serves for a token and mark of distinction given out in the orders of the day in time of peace, but in war every evening in the field, by the general who commands, and in garrison by the governor, or other officer commanding in chief, to prevent surprise, and hinder an enemy, or any treacherous person, from passing backwards and forwards. It may be changed whenever circumstances render it necessary. Its importance depends upon its being known only to the party interested in keeping it a secret. To communicate it to the enemy is a capital offence.

**Word**, in Language, an articulate sound representing some idea or conception of the mind. The copiousness of the English language is proved by the following enumeration of the words in Johnson's Dictionary: Articles 3—Nouns substantive 20409—Adjectives 9053—Pronouns 41—Verbs 7880; that is, active 5445; neuter 2425; passive 1; defective or imperfect 5; auxiliary 1; impersonal 3—Verbal noun 1—Participles 38—Participial adjectives 125—Participial nouns 3—Adverbs 496; Adverbs in *ly* 2096; total 2592—Prepositions 69—Conjunctions 19—Interjections 68.——Total 40,301.

It must be remarked, however, that in this list many of the compound words are not reckoned; that the participles are those only having no verbs to which they may be referred, as Beloved; that though so few verbal and participial nouns are stated by Johnson, yet every active participle may supply one of the former description, and every verb one of the latter; and that both these (verbal and participial nouns) seem to be merely different applications of a true gerund.

WORK (To), to direct the movements of a ship, by adapting the sails to the force and direction of the wind. A ship is also said to work when she strains and labours heavily in a tempestuous sea, so as to loosen her joints or timbers. *To Work Double Tides*, a phrase used in the dock-yards, implying that the people perform the work of three days in two. *To Work up Junk*, to draw yarns from old cables, &c. and therewith to make foxes, points, gaskets, sinnet, or spun-yarn.

WORKING IN HARVEST. A person may go abroad to work in harvest, carrying with him a certificate from the minister, and one churchwarden or overseer, that he has a dwelling-house, or place in which he inhabits, and that he has left a wife and children, or some of them there (or otherwise as his condition shall require), and declaring him an inhabitant there.

WORKING TO WINDWARD, the operation by which a ship endeavours to make a progress against the wind.

WORMING, the act of winding a rope spirally about a cable, so as to lie close along the interval between every two strands; a smaller rope is wormed with spun-yarn. It is generally used as a preparative for serving, and causes the service to lie smooth and round. This is also called *Link-Worming*. Cables may frequently be preserved by means of chains twisted round them in the following manner:—Take three chains of about fifteen fathoms each in length, all of an equal size, and proportioned in thickness to the nature of the case. Let them be wound round the cable, so that they may project sufficiently to receive the greatest part of the friction, one end of them being fastened to the ring of the anchor, and each chain being from thence wormed round its respective hollow or channel of the cable, so as not to check it from stretching. Fasten the other ends of the chains to the cable. It is not necessary that the chains should be very heavy, but extremely advisable that the links should be short, because they will be thereby more pliant, and worn much easier. These chains will completely guard the cable against the chafing of the rocks, and they may be put on in a few minutes, so that it is unnecessary to have them fitted on, but when it is probable they may be really serviceable. A due attention to shortening cables at the slack of the tide, and veering out as it flows, must also be highly important to prevent their being damaged. But it frequently happens that cables are suffered to kink, as it is called, through inattention to these circumstances, and to avoid a little trouble. If the wind should freshen when they are in this condition, though the cables be ever so good, the first foul sea that comes against them is almost sure to occasion their snapping; and vessels may be driven on shore, and much damaged, at least, if not totally lost, before they can possibly be brought up to other anchors, that may not always be in a state of readiness; for if there be an inattention and carelessness in one respect, there may be the same probably in others of equal importance. As the weight of the three chains, even for a large cable, will not exceed 500 pounds weight, the only difficulty which remains to be obviated will arise from the smallness of the hawse-holes, but these could be enlarged in vessels that shall deem it of sufficient moment to make the trial, and with the additional resistance of a boy or spare man at the head of the vessel, to cast off the chains as they come up, and hand them in above, all inconvenience will be removed. Admitting, indeed, that it may take up a few minutes more to weigh an anchor so secured than a common one, surely this can be no argument against a measure that tends to preserve and ensure the safety of the vessel and ship's company.

It may not be improper to recommend further, in high latitudes, where ice may cut or damage the cables while riding at anchor, the use of three other chains of the same nature as the preceding, but not more than five or six fathoms in length. These may be wormed round the cables in the same manner at the surface of the water, and will be an excellent means of guarding them from the ice, so as either to prevent its wounding them, or chafing them quite asunder: a circumstance which is not unprecedented in our harbours or rivers, but which frequently happens on the continent of Europe.

WORM, an instrument used to pieces of artillery, to draw the charge, or to take out the bottom of the cartridge, which sometimes remains in the chamber after firing, and which, by being on fire, might explode the next charge while being rammed home, whereby the man would probably lose both his hands; hence it is indispensably requisite that a gun should be wormed at least every third discharge.

WORM-*eaten*, the state of a plank, or of a ship's bottom, when a number of cavities are made in it by a particular kind of worm which abounds in the tropical climates.

WORMS. *See* VERMES.

WORSTED, a kind of woollen thread, which in the spinning is twisted harder than ordinary. It is chiefly used either wove or knit into stockings, caps, gloves, or the like.

WOULFE'S CHEMICAL APPARATUS *for separating Gas from Vapour*.—In every process of distillation, the matters separated and evolved by the application of heat, pass from the distilling vessel to the receiver, either in the form of vapour or of gas, or in both of these forms. If only vapour or steam be the product, it may, by cooling, be condensed into a liquid, in a common receiver of any kind; as takes place in distilling a spirit from wine, from wash, from ale, or other fermented vinous liquors. If the product be a gaseous fluid alone, that cannot be so condensed, it may prove to be soluble in water in a greater or less proportion; as in the distillation of muriatic acid, nitric acid, ammonia, &c. The matter evolved from the materials in the distilling vessel, may be partly vapour and partly gas. In this case the vapours may, as above, be condensed, and obtained in a liquid form; and the gas, if soluble in water, may, combined therewith, be obtained separately in a liquid solution. But the gas that comes over with the vapour may be insoluble in water. In this case, though the vapour, as before, may be condensed, the gas, without an appropriate apparatus, must be lost. To the want of such apparatus may be ascribed the comparatively slow progress that was for many ages made in chemical science. By means of a suitable apparatus, the gas, whether soluble or insoluble in water, whether accompanied or not with vapour in coming over, may be collected without any loss. When the gas evolved is partly soluble in water and partly insoluble, which sometimes happens, the soluble portion combined with water, the insoluble in the form of gas, and such liquid as may have been produced by the condensation of vapour, may all three be obtained separately and without any loss. To effect these objects with accuracy and facility remained a desideratum, till Woulfe's apparatus, so named from its inventor Peter Woulfe, was introduced into the laboratory.

*Woulfe's Apparatus*,—for chemical and pharmaceutical operations, is commonly formed of flint glass; but in large manufactories it is sometimes constructed partly of wood and partly of lead or other metals, according to circumstances. The following are the parts of which it is composed:—

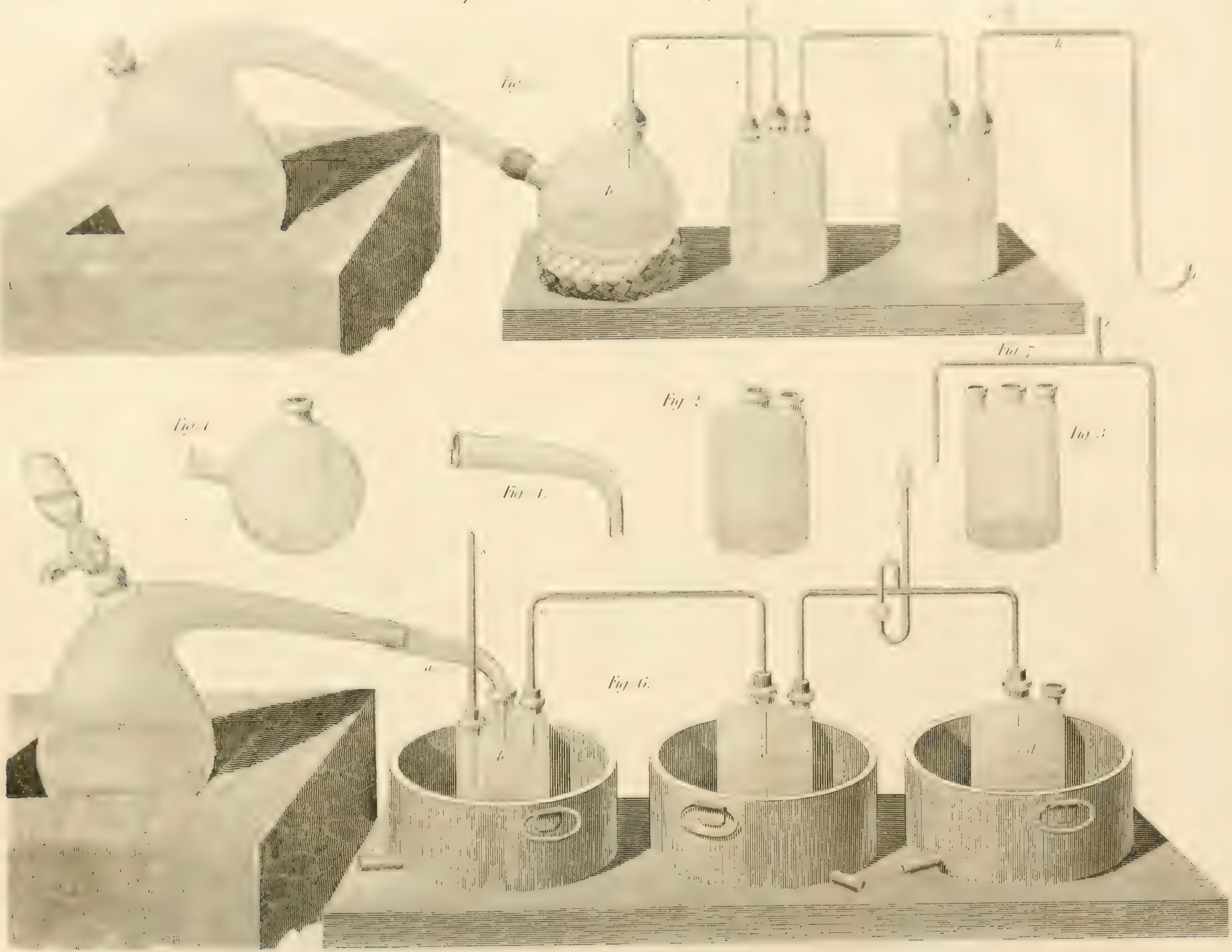
Figure 1. A balloon with two openings; one to receive the beak of a retort, the other for introducing a connecting-tube, to join it to one of Woulfe's bottles.

Fig. 2, one of these bottles with two necks.

Fig. 3, another bottle with three necks.

Fig. 4, an adaptor, for making a communication between retorts, balloons, bottles, &c.

Connecting tubes are inserted in the necks of the bottles by means of perforated corks, in which a hole is made to fit the tubes, by employing a round file till the tubes may be firmly fixed in them. The outsides of the corks are made to fit the necks by means of a coarse file. Sometimes the bottles and



J. Lamy sculp

connecting tubes are joined to each other by corks alone: at other times they are luted. In joining the retort with the balloon, or the adaptor with the retort and the bottles, lute alone should be employed, some of which should be pressed in at the place of juncture, that the vessels may be prevented, by means of the interposed lute, from touching each other. The least troublesome method of closing the junctures is, by having the connecting tubes ground as stoppers to fit the necks of the bottles; but as they are much exposed to the danger of being broken, they are often dispensed with on account of the cost.

Fig. 5, the apparatus with luted joinings, as arranged for distillation, in which both liquids and gases are produced.

Fig. 6, the apparatus as employed in distillations, in which the products pass over in the form of gas only: not luted, but furnished with refrigeratory vessels.

Fig 7, a connecting tube with a small capillary safety-tube, *z*, attached to it.—Connecting tubes are generally made of glass, but better, when the products of the process admit of it, of lead tube, or of tubes made of caoutchouc.

We shall describe each of these arrangements, and illustrate them by actual examples of operation; and the latter being, in some respects, the simpler of the two, we shall begin with it.

When the product of the distillation is merely gaseous, but soluble in water, the earthen or glass retort, *r*, fig. 6, placed on the naked fire, or in a water-bath, or in a sand-heat, as the case may require, is joined by means of an adaptor *a*, with the central neck of the bottle *b*, in one of the side necks of which the safety-tube *s* is inserted, in such a manner as nearly to touch the bottom. The other neck of this bottle is made to communicate with the two-necked bottle *c* by means of the connecting-tube *e*, bent into the form of the letter п, but with unequal legs, so that the shorter leg reaches only within the neck of the bottle *b*, while the longer reaches almost to the bottom of the two-necked bottle *c*: this second bottle is combined in like manner with the third bottle *d*; but it is better that in this communication the connecting-tube should have a little capillary tube, as shewn at *z*, fig. 7, for the occasional admission of air when condensation or absorption takes place in the apparatus,—or, which is still preferable, the connecting tube may be joined with that kind of safety-tube represented at *f*, and which goes by the name of its inventor, Welter.—This would always be employed, but for its being very easily broken. Some people, however, prefer, on every occasion, three-necked bottles only, with safety-tubes in each, like the tube *s* shewn in the bottle *b*.

In the first bottle *b*, a sufficient quantity of water is introduced to have the safety-tube *s* immersed about half an inch; and in the second and third, that quantity which experience has shewn to be necessary for the absorption of the gas. The safety-tube *s* is left open, but the capillary tube *z*, when made use of in the second communication, is luted in such a manner that it may be quickly opened; or if Welter's tube be employed, a little mercury is introduced, to close the lower bend. The second neck of the third bottle, or of the last in the series, when more are employed, may be left open, or slightly closed with a cork. The substances to be operated on are introduced into the receiver through the tubulure, when a tubulated receiver is made use of, and (for the process which we shall hereafter describe) a stopper may be used in place of the bottle with the stop-cock shewn as in the plate, and the joinings may be luted. As soon as the substances in the retort begin to act on each other, the gas that is liberated mixes with the common air in the retort and in the bottle *b*, and pressing on the water in the descending limb of the connecting-tube *e*, in the second bottle *c*, at length makes its passage good into *c*, and rising in bubbles through the water therein, passes on, in like manner, to the bottle *d*. During this transition the gas is absorbed by the water, an affect which is promoted by the compression both of the gas and the water, also by the minute division and consequent increase of acting surfaces of gas, and by the cooling process carried on at the same time by means of the refrigeratory vessels exhibited in the plate,—the heat disengaged from the gas in passing to the liquid state, being often such as to cause the water to boil. But refrigeratory vessels are not always necessary. If, by accident or inattention, the heat be urged more than necessary, the gas will be produced in greater quantity than the connecting tubes can pass: then water will be forced from the bottle *b* up the safety-tube, till the surface of the water in *b* is reduced low enough to admit common air. Thus the safety-tube prevents the apparatus from being broken. As the density of the water is increased by absorbing the gas, the passage of which to the next bottle is thereby rendered more difficult, it is better to employ a greater number of bottles than to have the water too high in those made use of. As soon as the development of the gas begins to decrease, the water of the tube of safety descends. This happens either towards the end of the operation, or when the heat is imprudently diminished. If the apparatus be then perfectly cooled, the air in the first bottle is condensed to such a degree, that the atmospheric air enters the tube of safety. But for this tube, the water contained in the second bottle would necessarily come over into the first It would be the same with the third bottle, were not the capillary tube of the second communicating tube opened, and the atmospheric air admitted. If the communicating tube be without a capillary tube, the luting of the third bottle must be instantly opened, and the bottle itself removed. The height of the water in the safety-tube decreases also at last, in consequence of the second and third bottle becoming cooler, or when from any other cause the absorption of the gas is more rapid than its production. It also frequently happens in the midst of the operation, that the gas, instead of being evolved, is absorbed for a short time by the mass contained in the retort, or that the volume of this mass is otherwise suddenly diminished, which, in like manner, causes the water in the safety tube to fall. The safety-tube, therefore, not only defends the apparatus from breaking, but also prevents the fluids in the bottles from mixing. It serves moreover, as a mean by which we may judge of the progress of the operation. If, during the progress, a small quantity of gas, unabsorbed, is observed to pass through the open neck of the third bottle, a fourth bottle is immediately to be joined with the third, in the same manner as the third is connected with the second. But on this occasion it should be recollected, that the pressure is increased in the first bottle, and the safety-tube should be consulted. When the operation is finished and the apparatus cooled, the water contained in the bottles will be found impregnated with the developed gas, and more so in the first bottle than in the last. The liquor contained in the first bottle is frequently not quite pure, because the small quantity of the body which comes over in the liquid form carries along with it the impurities of the distilled substances; the other liquors are, however, perfectly pure. If the weight of the water poured into each bottle has been accurately determined, it will be easy, after the operation is finished, to ascertain in the most precise manner, from the increase of weight, not only the whole weight of the gas obtained, but also the degree of concentration of the fluids in each bottle. By way of example, we will state the result of a real operation.

*Preparation of Liquid Ammonia.*—To obtain liquid ammonia, formerly called volatile spirit of ammonia, and more commonly spirit of hartshorn, one pound and a half of dry muriate of ammonia, (sal ammoniac,) and four pounds and a half of quicklime, both in fine powder, were employed in the following manner:—Half a pound of lime was put at the bottom of the retort by itself; upon this was thrown a mixture of three and a half pounds of lime and one and a half pound of sal ammoniac: and lastly, the remaining half pound of lime was put in. The retort was placed on a sand bath, and connected with an apparatus of the nature before described. Distillation was now commenced, and continued, by a heat gradually increased to the ignition of the retort, till the gas ceased to come over. To immerse the tube of safety, three ounces of distilled water were poured into the bottle *b*, half a pound into *c*, and half a pound into *d*. When the apparatus was opened, the first bottle was found to contain 4 ounces 2 drams 40 grains of a foul weak solution of ammonia; the second bottle, 1½ ounce 28 grains of strong and pure liquid ammonia; and in the third bottle, 9¼ ounces 3 drams 16 grains, of an equally pure but weaker solution.

| Bottle. | Water | Increase. | | |
|---|---|---|---|---|
| *d* | 3 ounces | 1 ounce | 2 drams | 40 grains |
| *b* | 8 ounces | 4 ounces | ——— | 28 grains |
| *c* | 8 ounces | 1 ounce | 7 drams | 16 grains |
| | 19 ounces | 7 ounces | 2 drams | 24 grains |

From this it appears, that 1½ pound of sal ammoniac afforded 7 ounces 2 drams 24 grains of pure ammoniacal gas, which, dissolved in 19 ounces of water, formed 26 ounces 2 drams 24 grains of liquid ammonia, of which the small portion contained in the first bottle being weak and impure, may be rejected; that contained in the second bottle was very strong, since two parts water contained one part of ammonia; that in the third portion was also pure, but weaker, the proportion of the ammonia to the water being about 1 : 5. The residue left in the retort, after the foregoing process, is muriate of ammonia. The rationale of the process is simply this: sal ammoniac is composed of muriatic acid, and pure ammonia; and the chemical attraction of this acid being greater for lime than for ammonia, it combines with the lime, liberating the ammonia, which assumes the gaseous form.

Pure ammonia—the base of the gas produced in the manner that has been described, and which, dissolved in water, forms liquid ammonia—is itself a compound of nitrogen (or azote), and 17 : 64 of hydrogen by weight, in 100 parts.

When the products which come over in distillation are partly liquid and partly gaseous, the apparatus is arranged as in fig. 5. The beak of the retort *a* is inserted in the tubulated balloon *b*, which communicates with the three-necked bottle *c*, by means of the connecting tube *f*, the descending ends of which are of equal length, and enter only within the necks of *b* and *c*. In one of the necks of the bottle *c* is introduced the safety-tube *e*, made to dip only a little way into the contained liquid, to shut out the air during the distillation. The third neck of *c* communicates with a second bottle *d*, by another connecting tube *g*, one end of which is made long enough to descend almost to the bottom of the bottle *d*, while the other end only enters the neck of *c*.—When necessary, a third bottle, or any number, may be joined to the series in the same manner.

When the apparatus is thus arranged, the balloon *b* is left empty, water is introduced into the first bottle *c*, high enough to cover the orifice of the safety-tube, and also into the second and third bottles, but in greater quantity, to absorb the gas when it passes over. What passes in distillation in the liquid form, collects in the bottom of the balloon; but the gaseous fluid carrying with it the common air out of the apparatus, passes on through the connecting-tube *f*, into the bottle *c*, and thence through the tube *g* into the bottle *d*,—the gas in its passage combining with the water in *c* and *d*. When the operation is finished, the liquid product is found in the balloon, and the gas combined with the water in the second bottle—and also in the third, fourth, &c. when the process requires so many. The bottle *d* might communicate directly with the balloon, without the intervention of the bottle *c*,) in the same manner as it now communicates with *c*; but the safety-tube *e* in the latter is of great use, as it not only serves to indicate the progress of the operation, but answers another pupose. It is hardly possible to prevent a partial vacuum from being formed in the retort towards the close of the distillation, either from accidental cooling, or from the production of gas or vapour beginning to slacken, and its consequent contraction in bulk by cooling. This causes a similar vacuum to be formed in the balloon, to fill which, a strong suction or absorption of the liquid from the first bottle, (which, in the case we allude to, would be *d*,) would take place through the connecting-tube, causing therein a vacuum, which, in like manner, would produce a similar effect on the one next to it, and so through the whole series of connected bottles; and the different products, in the different bottles, would thus come to be mixed. But this mischief is obviated by the employment of Woulfe's intermediate bottle *c*, with the safety-tube *e*; for the external air pressing on the small column of water in the safety-tube, and displacing it, enters the bottle, and destroys the vacuum.

This tube answers yet another good end. If the gas be liberated too quickly to be easily passed over by the connecting-tubes, it then presses the surface of the liquid contained in *e*, which finding a passage up through the tube *e*, is thereby expelled, and a rupture of the apparatus is prevented. This waste, however, should be as much as possible prevented; for which purpose the upper end of the safety-tube may be introduced into a funnel, by being passed through a perforated cork in the pipe thereof.

WRECK, the ruins of a ship which has been stranded, or dashed to pieces on a shelf, rock, or lee-shore, by tempestuous weather, or by accident.

WRECK is also the name of a soft slippery marine plant that grows on the rocks, having leaves somewhat resembling those of the oak. In many places it is used as manure, but in others being burnt, the ashes make a kind of soda or potash, found valuable in the manufacture of glass.

WREN, SIR CHRISTOPHER, an eminent English philosopher and mathematician, and one of the most learned and celebrated architects of his age, was born at Knoyle, in Wiltshire, in 1632. In 1660, he invented a method for the construction of solar eclipses; and in the latter part of the same year, he, with ten other gentlemen, formed themselves into a society, to meet weekly, for the improvement of natural and experimental philosophy, being the foundation of the Royal Society; of which learned body he was chosen president in 1680. He died in 1723, at 91 years of age.

WRIGHT, EDWARD, an English mathematician, was born in Norfolk about the middle of the 16th century, and died in 1615. He was one of those who laboured to bring the logarithmic tables of Napier and Briggs to perfection, and was the inventor of that division of the meridian on which the mercator's sailing is founded. He was also the author of two works of navigation, the one entitled, "The Correction of certain Errors in Navigation," published in 1599; and the other entitled "The Haven-finding Art," of which the date is not mentioned.

WRING (To) A MAST, is to bend or strain it out of its natural position, by setting the shrouds up too taught. This phrase is also applied to a capstan, &c. when by too great a strain the component parts of the wood become deranged, and are thereby disunited.

WRING *Bolts*, are bolts used by shipwrights to bend and secure the planks against the timbers, till they are properly fastened by bolts, spikes, and tree-nails.

WRING-*Staves*, bars of wood, used with the preceding article.

WRIT, is the king's precept by which any thing is commanded touching a suit or action: as the defendant or tenant to be summoned, a distress to be taken, a disseisin to be redressed, &c. And these writs are diversely divided; some, in respect of their order or manner of granting, are termed original, and some judicial.

WRIT *of Inquiry of Damages*, a judicial writ that issues out to the sheriff, upon a judgment by default, in action of the case, covenant, trespass, trover, &c. commanding him to summon a jury to inquire what damages the plaintiff has sustained, occasione præmissiorum; and when this is returned with the inquisition, the rule for judgment is given upon it; and if nothing is said to the contrary, judgment is thereupon entered..

WRITER *of the Tallies*, an officer of the exchequer, being clerk to the auditor of the receipt, who writes upon the tallies the whole of the letters upon the teller's bill.

WRITERS *to the Signet*. In the Scotch law, attorneys or solicitors who conduct causes before the courts of Edinburgh. They were so called at first from their having the exclusive privilege of preparing papers requiring the king's signet.

WRONG STAMP. By 37 George III. c. 136, any instrument (except bills of exchange, promissory notes, or other notes, drafts, or orders) liable to stamp duty, whereon shall be impressed any stamp of a different denomination, but of an equal or greater value than the stamp required, may be stamped with the proper stamp after the execution, on payment of duty and five pounds penalty, but without any allowance for the wrong stamp. Likewise any such instrument (except as aforesaid) being engrossed without having been first stamped, or having a stamp thereon of less value than required, the same may be stamped after the execution, on payment of the duty and ten pounds penalty only, for each skin thereof; but in case it shall be satisfactorily proved to the commissioners of stamps, that the same hath been so engrossed either by accident or inadvertency, or from urgent necessity, or unavoidable circumstances, and without any intention of fraud, the commissioners are authorized to stamp the same within sixty days after the execution, to remit the penalty in part, or wholly, and to indemnify persons so engrossing the same.

# X.

X, or X, the twenty-second letter of our alphabet. In numerals it expresses 10, whence in old Roman manuscripts it is used for denarius; and, as such, seems to be made of two V's placed one over the other. When a dash is added over it, thus X, it signifies ten thousand.

XEBEC, a small three-masted vessel, navigated in the Mediterranean sea, and distinguished from other European vessels by the great projection of the prow and stern beyond the cut-water and stern-post respectively. The sails are in general similar to those of the polacre, but the hull is different. Being generally equipped as a corsair, it is constructed with a narrow floor, to be more swift in pursuit of the enemy; and of a great breadth, to enable her to carry a considerable force of sail for this purpose, without danger of overturning. As these vessels are usually very low built, their decks are formed with a great convexity from the middle of their breadth towards their sides, in order to carry off the water which falls aboard more readily by their scuppers. But as this convexity would render it difficult to walk thereon at sea, particularly when the vessel rocks by the agitation of the waves, there is a platform of grating extending along the deck from the sides of the vessel towards the middle, whereon the crew may walk dry-footed whilst the water is conveyed through the grating to the scuppers. When a xebec is equipped for war, she is occasionally navigated in three different methods, according to the force or direction of the wind. Thus, when the wind is fair, and nearly astern, it is usual to extend square sails upon the main-mast, and indeed, frequently on the fore-mast; and as those sails are rarely used in a scant wind, they are of an extraordinary breadth. When the wind is unfavourable to the course, and yet continues moderate, the square yards and sails are removed from the masts, and laid by in order to make way for the large lateen yards and sails, which soon after assume their place; but if the foul wind increases to a storm, these latter are also lowered down and displaced, and small lateen yards, with proportionable sails, are extended on all the masts. The xebecs, armed as vessels of war by the Algerines, mount from 16 to 24 cannon, and carry from 300 to 450 men, two-thirds of whom are commonly soldiers. The method of working these vessels is so exceedingly complicated and difficult, that the labour is considerable.

XIPHIAS, the *Sword Fish*, in Natural History, a genus of fishes, of the order apodes. There are three species: The common sword-fish, of the length of twenty feet, which is particularly distinguished by its upper jaw being stretched to a considerable distance beyond the lower, flat above and beneath, but edges at the sides, and of a bony substance, covered by a strong epidermis. It is a fish extremely rapacious, and finds in the above instrument a weapon of attack and destruction, able to procure it the most ample supplies. It first transfixes its prey with this snout, and then devours it. It is found in the Mediterranean, chiefly about Sicily, and is used as food by the Sicilians, who preserve it for a long time by salting it in small pieces.—The broad-finned sword-fish, is found in the northern Atlantic and Indian seas, and is considered as one of the most fatal enemies of the whale tribe. Its strength is so great, that it is said to have pierced with its snout, or sword, the plank of an East Indiaman; and a plank and snout, in attestation of this circumstance, the latter closely driven into the former, are to be seen in the British Museum, having been communicated to Sir Joseph Banks by an East India captain of honour and veracity. When young, this fish is used for food.—The European sword-fish, is known by having its upper jaw lengthened into a hard and sword-shaped blade; and its dorsal fin long, and lowest in the middle. These fish are of steel-blue colour, and measure from fifteen to twenty feet in length. They are found in most of the European seas. By the ancient Romans, sword-fish were highly esteemed as food; and were killed with harpoons by persons stationed in boats for that purpose. They were not only eaten fresh, but cut into pieces and salted. In several places near the Mediterranean, the fins are salted, and sold under the name of *callo*.

XIPHIAS, in Astronomy, the *Dorado*, or *Sword Fish*. See CONSTELLATION.

XIPHIAS is also a term used to express a fiery meteor, that is said to appear in the form of a sword; and which is sometimes called *Acontias*, from its resemblance to a serpent thus denominated in Calabria and Italy, where it is well known.

# Y.

Y, the twenty-third letter of our alphabet. Y is a numeral, signifying 150, or, according to Baronius, 159; and with a dash at top, as Y, it signifies 150,000.

YACHT, a vessel of state, usually employed to convey princes, ambassadors, or other great personages, from one kingdom to another. As the principal design of a yacht is to accommodate the passengers, it is usually fitted with a variety of convenient apartments, with suitable furniture. The royal yachts are commonly rigged as ketches, except the principal one, which is equipped as a ship. They are commanded by post-captains of the navy. The smaller yachts, which are rigged as sloops, are destined for the use of the commissioners of the navy, &c. Private pleasure boats, when sufficiently large for a sea voyage, are also termed yachts.

YANOLITE. Axinite.

YARD, a long piece of timber suspended upon the masts of a vessel, to extend the sail to the wind. They are either square, lateen, or lug-sail; the first are suspended across the mast at right angles, and the two latter obliquely. The square yards are of a cylindrical form, tapering from the middle, which is called the slings, towards the extremities, which are termed the yard-arms, and the distance between the slings and the yard-arms on each side, is by the artificers divided into quarters, which are distinguished into the first, second, and third quarters, and yard-arms. The middle quarters are formed into eight squares, and each of the end parts is figured like the frustrum of a cone. All the yards of a ship are square, except that of the mizzen. The proportions for the length of yards, according to the different classes of ships in the British navy, are as follow:—

| | | | |
|---|---|---|---|
| 1000 : gun deck : : ..... | 560 :<br>559 :<br>570 :<br>576 :<br>575 :<br>561 : | Main yard ......... | 100 *Guns.*<br>90, 80<br>70<br>60<br>50<br>44 |
| 1000 : main yard : : ..... | 880 :<br>871 : | fore yard .......... | 100, 90, 80.<br>all the rest. |

To apply this rule to practice, suppose the gun-deck 144 feet; the proportion for this length is, as 1000 to 575, so is 144 to which will be the length of the the main yard in feet, and so of all the rest.

| | | | |
|---|---|---|---|
| 1000 : main yard : : .... | 820 :<br>847 :<br>840 : | mizzen yard ........ | 100, 90, 80<br>60, 44<br>70<br>24 |
| 1000 : main yard : : .... | 726 :<br>720 : | main top sail yard .... | 24<br>all the; rest. |
| 1000 : fore yard : : .... | 719 :<br>726 :<br>715 : | fore top sail yard .... | 70<br>24<br>all the rest. |
| 1000 : main top sail yard : : | 690 : | main top sail yard .... | all the rates. |
| 1000 : fore top sail yard : : | 696 :<br>690 : | fore top gallant yard .. | 70<br>all the rest. |
| 1000 : fore top sail yard : : | 768 :<br>750 : | mizzen top gallant yard | 70<br>all the rest. |

Cross-jack and sprit-sail yards equal to the fore-top sail-yard. Sprit-sail top-sail yard equal to the fore-top-gallant yard. The diameters of the yards are in the following proportions to their length:—The main and fore yards, five-sevenths of an inch to a yard. The top-sail cross jack and sprit-sail yards, nine-fourteenths of an inch to one yard. The top-gallant, mizzen-top-sail, and sprit-sail top-sail yards, eight-thirteenths of an inch to one yard. The mizzen-yard, five-ninths of an inch to one yard. All studding-sails, booms, and yards, half an inch to one yard in length. The large lateen yards are usually composed of several pieces fastened together by wooldings, which also serve as steps, whereby the sailors climb to the peek or upper extremity, in order to furl or cast loose the sail. The mizzen yard of a ship, the main yard of a bilander, and the yards of a lugger, though they are not, strictly speaking, lateen sails, are nevertheless hung obliquely on the mast, and the slings are nearer the fore-end than the aftmost end or peek.

YARD *Tackles*, strong tackles suspended from the main and fore-yards of a ship of war, &c. whereby, with the assistance of the stay-tackles, the boats and other weighty matters are hoisted in and out.

*To Brace the* YARDS, to traverse them about the masts so as to form greater or lesser angles with the ship's length. See the article BRACE.

YARD *Arm*, is that half of the yard that is on either side of the mast, when it lies athwart the ship.

*Yard-Arm and Yard-Arm*, a phrase applied to two ships, when they are so near, that their yard-arms nearly touch each other.

YARD-*Arm Pieces*, pieces of timber kept in readiness to repair the yard-arms in the event of their being carried away or broken.

YARDS, also denote places belonging to the navy, where the ships of war, &c. are laid up in harbour. There are belonging to his majesty's navy, six great yards, *viz.* Chatham, Deptford, Woolwich, Portsmouth, Sheerness, and Plymouth; these yards are fitted with several docks, wharfs, launches, and graving places, for the building, repairing, and cleaning of his majesty's ships; and therein are lodged great quantities of timber, masts, planks, anchors, and other materials: there are also convenient store-houses in each yard, in which are laid up vast quantities of cables, rigging, sails, blocks, and all other sorts of stores, needful for the royal navy.

YARD, an English measure of length, and used also by several other European nations. The English yard contains 3 feet, and is equal

to 4-5ths of the English ell,
to 7-9ths of the Paris ell,
to 4-3ds of the Flemish ell,
to 56-5ths of the Spanish vasa or yard.

YARN, wool or flax spun into thread, of which cloth is made; or, in a nautical sense, it signifies one of the threads of which ropes are composed. The thread, or twisted line of hemp, is the first and principal part of a rope. A number of these are twisted together to form a strand, in proportion to the size of the rope whereof the strand makes a part. Three strands are then twisted into one another, which completes the process of ordinary rope-making. But cables, hawsers, and other ground tackling, are composed of three strands, each of which is formed by three lesser ones. *See* CABLE.

Yarn is ordered after the following manner: After it has been spun upon spindles, spools, or the like, they wind it upon reels which are hardly two feet in length, and have but two contrary cross bars, being the best and the least liable to ravelling. In reeling of yarn, the better to keep it from fine ravelling, you must, as it is reeled, with a by-band of big twist, divide the slipping or skein into several leys, allowing to every ley eighty threads, and twenty leys to every slipping, if the yarn is very fine, otherwise less of both kinds. The yarn being spun, reeled, and in the slipping, the next thing is to scour it. In order to fetch out the spots, it should be laid in lukewarm water for three or four days, each day shifting it once, wringing it, out and laying it out in another water of the same nature; then carry it to a well or brook, and rinse it till nothing comes from it but pure clear water; that done, take a bucking-tub, and cover the bottom thereof with very fine ashen ashes; and then having opened and spread the slippings, covering them with ashes as before, and thus laying one upon another till all the yarn be put in, afterwards cover the uppermost yarn with a bucking-cloth, and in proportion to the bigness of the tub lay therein a peck or two more of ashes: this done, pour upon the uppermost cloth a great deal of warm water till the tub can receive no more, and let it stand so all night. Next morning you are to set a kettle of clean water on the fire, and when it is warm pull out the spiggot of the bucking-tub, to let the water run out of it into another clean vessel. As the bucking-tub wastes, fill it up again with the warm water on the fire; and as the water on the fire wastes, so likewise fill that up with the ley that comes from the bucking-tub, ever observing to make the ley hotter and hotter till it boils; then you must, as before, ply it with the boiling ley, at least four hours together, which is called the driving of a breek of yarn. Of yarn thus prepared, are made the sails, cloths, &c. used in vessels.

YARN-*Mill.* This machine may be worked by water, or as a horse-mill, or in any other way, and is made and used in the following manner. There is a cylinder marked A, plate *Watch*, &c. fig. 1, three feet diameter, and ten inches broad, made of dry wood or metal, turned true, and covered on its circumference with a smooth leather, upon which are placed the rollers marked D, covered with leather, and supported in their situations by the slits in the covered piece of wood marked K, in which the iron axes of the rollers turn, but suffers them to press on the wheel marked A. There must be another piece similar to the above, to support the other end of the rollers. These rollers are of different weights. The upper roller marked D I is two stone, the rest decreasing to the last, which is only two pounds weight and one half. There is an iron fluted roller marked F, furnished with a toothed wheel at each end, and a wood one, marked G, covered with cloth, and over it a smooth leather. There is an assisting roller, marked H, of fluted iron. These rollers are supported by their axes turning in the slit, marked 2, of the piece of wood, marked M, fig. 3, which is here separated from the end of the frame marked S, to shew the rollers and wheel-work. The rollers marked G and F are squeezed together by means of the lever marked *p*, and its weight marked *w*, fig. 3. The roller marked H is pressed to the mark G, by its axis acting upon the inclined plane marked *x*, fig. 3. There is a rubbing roller covered with woollen cloth, and on its axis is a small wheel marked I, driven by the wheel marked S. This roller rests upon the roller marked G, and by its motion prevents any dirt or fibres from adhering to it. There is a cloth, marked N, revolving over two rollers marked O, O, which has motion given it from the wheel marked C, by means of another wheel marked P, This cloth moves at the same rate as the surface of the wheel marked A. There is a supporter marked Y, of the axis of the wheel marked O, P, but is removed, in order to shew them; it is fixed by its tenons in the mortises, marked Z, Z. The roller marked B is kept in action by its endeavour to slip down the inclined plane at the top of the piece marked Y, thereby pressing against the revolving cylinder; and another piece similar to this, must be understood to support the other end of the roller's axis. By the side of this revolving cloth is a table placed, of the same length and breadth as the cloth is, to which belong two smooth cloths or leathers, of the same size as the table. The machine being thus prepared, the attendant or workman must take a quantity of hemp, tow, flax, or wool, more or less, according to the fineness of the thread to be made, and lay or spread it evenly upon one of the smooth cloths on the table, then place it on the revolving-wheel marked N, motion being communicated to the roller marked T, by wheel-work as usual, from a water, horse, or other kind of mill, which wheel-work is communicated to the wheel marked Q, on whose axis is a nut, which turns the wheel marked C; and thereby the cylinder marked A moves, and with it all the rollers; by which motion the hemp, tow, flax, or wool is drawn forward. The cloth turns down, but the hemp, tow, flax, or wool, go upon the cylinder marked A, under the roller marked B, and so forward under the rollers marked D, then falls in between the rollers marked G, F, turns under the roller marked G, and over the roller marked H, which, as it gives the rollers hold of the hemp, tow, flax, or wool, in two places, enables them to draw forward the long fibres thereof, though many of them are to draw from under the marks 4 or 5 of the pressing-rollers marked D, it then falls into a canister marked R, and as by the wheel-work the rollers marked F, G, H, move three times faster than the cloth and cylinder, the sliver must be three times longer than when presented. By the time this is drawing, the other cloth is filled with hemp, tow, flax, or wool, as before, and laid upon the revolving roller, laying the hemp, tow, flax, or wool, over the end of the other which goes forward as before, and thus a continued sliver is produced as long as the machine continues its motion. But in order that this sliver may come out of the canister marked R, without entanglement, it must pass through an instrument marked 5, fig. 3, placed over the rollers marked F, G, its open side marked T, to the cylinder at mark 4, supported by its ends marked V, V, in the slit marked W, of the before described pieces marked K. The aperture X is so small as to press the fibres close to each other in their passage through it previous to their passing the rollers, by which means they remain pressed side by side in the sliver, and will not entangle. These thick slivers are drawn smaller by a similar process, and in the same manner are used for cottons: but the machines for drawing are all of the same structure as the above, except that they have no revolving cloth. The sliver is applied to the cylinder under the roller marked B, which draws it forward under all the rollers as before described, drawing it out, or lengthening it, every fresh machine through which it presses, till it be small enough for the spinning machine. It must be remarked, that the cylinders are made less in diameter, according to the different smallness of the sliver intended to be drawn upon them at the first; whilst the sliver is at its greatest thickness, the cylinder is required to be three feet diameter as above described, the next rather less, and so on to the last, which is only two feet. The aperture of the bottom of the contractor belonging to each machine is also made one-third part smaller than another in succession, from the greatest to the smallest cylinder; as also the drawing rollers marked F, G, H, are furthest from the pressing-roller marked D, in the longest cylinder, and nearest at the smaller cylinder. At the largest cylinder the distance is about nine inches, and the smallest about four inches; but their distance cannot in all cases be fixed, as it depends on the different lengths of the slivers of the hemp, tow, flax, or wool; long ones requiring the distances mentioned, and short ones requiring the distances much shorter than is here specified.

The following several letters or marks are in the machine figured 2. The spinning machine, as to its drawing principle, is the same as the drawing machine. The slivers are presented to it in canisters marked A, and drawn over a cylinder marked B covered with rollers marked D. The fibres which are to form the thread are drawn from the cylinder by the rollers marked C, the under roller of which is made of fluted iron, the other of wood, covered with leather; they move six or eight times faster than the cylinder marked B are enabled to draw the hemp, tow, flax, or wool, forward from under the pressing-rollers marked D, by being squeezed together with the weights and crooks marked *a*, *a*, locked to the small part of the rollers marked C. There is a belt of smooth cloth marked E, moving on two rollers, which are turned by the wheel marked F, on the axis of the fluted roller; at the opposite end of which, as at the mark G, is a nut, which turns the wheel marked H, on whose axis is another nut, turning the wheel marked I, and thereby the cylinder marked B, with all its rollers. These rollers move in curved pieces of wooden metal, marked K, which, to prevent confusion, are not represented in their places; they have slits in them in which the rollers' axes are guided, but so deep as at all times to suffer the rollers to press upon the cylinder. These rollers are covered with cloth and leather. The top roller is about ten pounds weight, decreasing to the sixth roller, which is only about one pound weight: the yarn is turned by the spindles marked L, and rubbed over the wet cloth belt if spinning linen yarn, but if spinning worsted yarn the belt must be removed, that it may not touch it as it passes to the spool, which it coils round as fast as the rollers let it out. The spindles marked C are turned by a bolt from the wheel marked M, which derives its motion from the mill, and by a wheel on its axis communicates it to the roller under the mark C by the wheel marked F, and so to the rest, as above described. The hemp, tow, flax, or wool, is twined in the same manner as cotton is by mills.

**YAW**, the movement by which a ship deviates from the line of her course towards the right or left in steering.

**YAWL**, a boat usually rowed with four or six oars. See the article BOAT.

**YEAR**, in Astronomy and Chronology, the portion of time occupied by the sun in passing over the twelve signs of the zodiac, and in which is comprehended the several changes of the seasons. The mean solar year, according to the observations of the best modern astronomers, contains 365 days, 5 hours, 48 minutes, 48 seconds; the quantity assumed by the authors of the Gregorian calendar, is 365 days, 5 hours, 49 minutes; but in the civil or popular account the year contains 365 days, 6 hours, or rather 365 days for three years in succession, and every fourth year 366 days. *See* BISSEXTILE.

The vicissitude of seasons seems to have given occasion to the first institution of the year. Man, naturally curious to know the cause of their diversity, soon conjectured that it depended upon the motion of the sun, and therefore gave the name year to the space of time in which that luminary seemed to perform his whole course, by returning again to the same point of its orbit. According to the accuracy of their observations, the year of some nations was more perfect than that of others, but none of them quite exact, nor whose parts did not shift with regard to the parts of the sun's course.

According to Herodotus, it was the Egyptians who first formed the year, making it to consist of 360 days, which they subdivided into 12 months, of 30 days each. Mercury Trismegistus added five days more to the account; and which form of the year, Thales is said to have instituted amongst the Greeks; and hence, with successive improvements, it has been handed down to the moderns.

The *Solar* YEAR, is either astronomical or civil.

The *Astronomical Solar* YEAR, is that which is precisely determined by astronomical observations, and is of two kinds, *tropical*, and *sidereal* or *astral*.

*Tropical* or *Natural* YEAR, is the time which the sun, or rather the earth, employs in passing through the 12 signs of the zodiac, and which, as stated above, contains 365 days, 5 hours, 48 minutes, 48 seconds, which is the only natural year, because it always keeps the same seasons in the same months.

*Sidereal* YEAR, or *Astral Year*, is the space of time the sun takes in passing from any fixed star, till his return to it again. This consists of 365 days, 6 hours, 9 minutes, 11 seconds, being 20 minutes, 29 seconds longer than the true solar year.

*Anomalistic* YEAR, is the interval which is occupied by the sun in passing from apogee to apogee, or from perigee to perigee: it is greater than the sidereal year by the time required to describe the annual progression of the apogee. The length of the anomalistic year is 365 days, 6 hours, 14 minutes, 1 second.

*Lunar* YEAR, is the space of 12 lunar months. Hence, from the two kinds of synodical lunar months, there arise two kinds of lunar years; the one astronomical, the other civil.

*Lunar Astronomical* YEAR, consists of 12 lunar synodical months; and therefore contains 354 days, 8 hours, 48 minutes, 38 seconds, and is therefore 10 days, 21 hours, 0 minutes, 10 seconds, shorter than the solar year. A difference which is the foundation of the epact.

*Lunar Civil* YEAR, is either the common or embolismic.

The *Common Lunar* YEAR, consists of 12 lunar civil months; and therefore contains 354 days. And

The *Embolismic*, or *Intercalary Lunar* YEAR, consists of 13 lunar civil months, and therefore contains 384 days.

Thus far we have considered years and months with regard to astronomical principles, upon which the division is founded. By this, the various forms of civil years that have formerly obtained, or that do still obtain, in divers nations, are to be examined.

*Civil* YEAR, is that form of the year which every nation has contrived or adopted for computing their time by. Or the civil is the tropical year, considered as only consisting of a certain number of whole days: the odd hours and minutes being set aside, to render the computation of time, in the common occasions of life, more easy. As the tropical year is 365 days, 5 hours, 49 minutes, or almost 365 days, 6 hours, which is 365 days and a quarter; therefore, if the civil year be made 365 days, every fourth year it must be 366 days, to keep nearly to the course of the sun. And hence the civil year is either common or bissextile.

*Common Civil* YEAR, is that consisting of 365 days; having seven months of 31 days each, four of 30 days, and one of 28 days; as indicated by the following well-known memorial verse:—

Thirty days hath September,
April, June, and November;
February twenty-eight alone,
And all the rest have thirty-one.

*Bissextile*, or *Leap* YEAR, contains 366 days, having one day extraordinary, called the intercalary, or bissextile day, and takes place every fourth year. This additional day to every fourth year was first introduced by Julius Cæsar, who, to make the civil years keep pace with the tropical ones, contrived that the six hours which the latter exceeded the former should make one day in four years, and be added between the 24th and 23d of February, which was their 6th of the calends of March; and as they then counted this day twice over, or had *bis sexto calendas*, hence the year itself came to be called *bis sextus*, and *bissextile*. However, among us, the intercalary day is not introduced by counting the 23d of February twice over, but by adding a day at the end of that month, which therefore in that year contains 29 days. A farther reformation was made in the civil year by pope Gregory.

The civil or legal year, in England, formerly commenced on the day of the Annunciation, or 25th of March; though the historical year began on the day of the circumcision, or 1st of January; on which day the German and Italian year also begins. The part of the year between these two terms was usually expressed both ways; as 1745-6, or $174\frac{5}{6}$. But by the act for altering the style, the civil year now commences with the 1st of January.

*Ancient Roman* YEAR. This was the lunar year, which, as first settled by Romulus, contained only ten months, of unequal numbers of days, in the following order, *viz.*:—March 31; April 30; May 31; June 30; Quintilis 31; Sextilis 30; September 30; October 31; November 30; December 30; in all 304 days; which came short of the true lunar year by 50 days, and of the solar by 61 days. Hence, the beginning of Romulus's year was vague, and unfixed to any precise season; to remove which inconvenience, that prince ordered so many days to be added yearly as would make the state of the heavens correspond to the first month, without calling them by the name of any month. Numa Pompilius corrected this irregular constitution of the year, composing two new months, January and February, of the days that were to be added to the former year. Thus Numa's year consisted of 12 months, of different days, as follow, *viz.*:—

| | | | | | |
|---|---|---|---|---|---|
| January | 29; | February | 28; | March | 31; |
| April | 29; | May | 31; | June | 29; |
| Quintilis | 31; | Sextilis | 29; | September | 29; |
| October | 31; | November | 29; | December | 29; |

in all 355 days; therefore exceeding the quantity of a lunar civil year by one day; that of a lunar astronomical year by 15 hours, 11 minutes, 22 seconds; but falling short of the common solar year by 10 days, so that its beginning was still vague and unfixed. Numa, however, desiring to have it begin at the winter solstice, ordered 22 days to be intercalated in February every second year, 23 every fourth, 22 every sixth, and 23 every eighth year. But this rule failing to keep matters even, recourse was had to a new way of intercalating; and instead of 23 days every eighth year, only 15 were to be added. The care of the whole was committed to the pontifex maximus; who, however, neglecting the trust, let things run to great confusion. And thus the Roman year stood till Julius Cæsar reformed it.

The *Ancient Egyptian* YEAR, called also the year of Nabonassar on account of the epocha of Nabonassar, is the solar year of 365 days, divided into 12 months of 30 days each, besides five intercalary days added at the end. The names, &c. of the months are as follows:—1. Troth. 2. Paophi. 3. Athyr. 4. Chojac. 5. Tybi. 6. Mecheir. 7. Phamenoth. 8. Pharmuthi. 9. Pachon. 10. Pauni. 11. Epiphis. 12. Mesori; beside the *ἡ μεραι επαγομεναι.*

The *Ancient Greek* YEAR, was lunar; consisting of 12 months, which at first had 30 days apiece, then alternately 30 and 29 days, compared from the first appearance of the new moon; with the addition of an embolismic month of 30 days every 3d, 5th, 8th, 11th, 14th, 16th, and 19th year of a cycle of 19 years; in order to keep the new and full moons to the same terms or seasons of the year. Their year commenced with that new moon, the full moon of which comes next after the summer solstice. The order, &c. of their months was thus:—

1. ʽΕκατομβαιων, containing 29 days. 2. Μηταγείτνιων, 30. 3. Βοηδρομιων, 29. 4. Μαεμακτηριων, 30. 5. Πυανεψιων 29. 6. Ποσειδεων, 30. 7. Γαμηλιων, 29. 8. Αεθεςηριων, 30. 9. Ελαφηβολιων, 30. 10. Μȣνυχιων, 30. 11. Θαργηλιων, 29. 12. Σκιροφοριων, 30.

The *Ancient Jewish* YEAR, is a lunar year, consisting commonly of 11 months, which alternately contain 30 and 29 days. It was made to agree with the solar year, either by the adding of 11, and sometimes 12 days, at the end of the year, or by an embolistic month. The names and quantities of the months stand thus:—1. Nisan, or Abib, 30 days. 2. Jiar, or Zius, 29. 3. Siban, or Siwan, 30. 4. Thammuz, or Tammuz, 29. 5. Ab, 30. 6. Elul, 29. 7. Tisri, or Ethanim, 30. 8. Marchesvan, or Bull, 29. 9. Cisleu, 30. 10. Tebeth, 29. 11. Sabat, or Schebeth, 30. 12. Adar, in the embolismic year, 30. Adar, in the common year, was but 29. *Note*, in the defective year, Cisleu was only 29 days; and in the redundant year, Marchesvan was 30.

The *Persian* YEAR, is a solar year of about 365 days, consisting of 12 months of 30 days each, with five intercalary days added at the end.

The *Arabic*, *Mahometan*, and *Turkish* YEAR, called also the year of the Hegira, is a lunar year, equal to 354 days, 8 hours, and 48 minutes, and consists of 12 months, which contain alternately 30 and 29 days.

The *Hindoo* YEAR differs from all these, and is indeed different in different provinces of India. The best account that we have of it is by Mr. Cavendish, in the Philosophical Transactions of the Royal Society for the year 1792.

YEAR *and Day*, is a time that determines a right in many cases; and in some works an usurpation, and in others a prescription; as in case of an estray, if the owner, proclamation being made, challenges it not within the time, it is forfeited. So is the year and day given in case of appeal; in case of descent after entry or claim, if no claim upon a fine or writ of right at the common law; so of a villain remaining in ancient demesne; of a man sore bruised or wounded; of protections; essoins in respect of the king's service; of a wreck; and divers other cases.

YEARDAY AND WASTE, is a part of the king's prerogative, whereby he challenges the profits of their lands and tenements for a year and a day, that are attainted of petty treason or felony, whoever is lord of the manor where the lands or tenements belong; and not only so, but in the end may waste the tenements, destroy the houses, root up the woods, gardens, and pasture, and plough up the meadows, except the lord of the fee agrees with him for redemption of such waste, afterward restoring it to the lord of the fee.

**YEARS, Estate for.** Tenant for term of years, is where a man lets lands or tenements to another, for a certain term of years agreed upon between the lessor and lessee; and when the lessee enters by force of the lease, then he is tenant for term of years.

**YEAST**, is the barm or froth which rises in beer, and other malt liquors, during a state of fermentation. When thrown up by one quantity of malt or vinous liquid, it may be preserved, to be put into another at a future period, on which it will exert a similar fermentative action. Yeast is likewise used in the making of bread, which without such an addition would be heavy and unwholesome.

**YELLOW, Naples**, a fine pigment, so called from the city in which it was long prepared,

**YEOMAN**, is defined to be one that has fee land of 40s. a year; who was thereby heretofore qualified to serve on juries, and can yet vote for knights of the shire, and do any other act where the law requires one that is *probus et legalis homo.*

**Yeoman**, an inferior officer under the boatswain, gunner, or carpenter of a ship of war, and usually charged with the stowage, account, and distribution of their respective stores.

**Yeoman** *of the Guard*, one belonging to a sort of foot guards, who attend at the palace. The yeomen were uniformly required to be six feet high. They are in number 100 on constant duty, and 70 off duty. The one half carry arquebuses, and the other pertuisans. Their attendance is confined to the sovereign's person, both at home and abroad. They are clad after the manner of king Henry VIII.

**YOKE**, in Agriculture, a frame of wood fitted over the necks of oxen, whereby they are coupled together, and harnessed to the plough.

**Yoke**, a small board which crosses the upper end of a boat's rudder at right angles, and having two lines extending from its opposite extremities to the stern-sheets of the boat, whereby she is steered as with a tiller.

**YOLK**, is an animal soap, the natural defence of the wool of sheep. In washing sheep, the use of water containing the carbonate of lime should be avoided; for this substance decomposes the yolk of the wool, and wool often washed in calcareous water becomes rough and more brittle. The finest wool, such as that of the Spanish and Saxon sheep, is most abundant in yolk. M. Vauquelin has analyzed several different species of yolk, and has found the principal part of all of them a soap, with a basis of potassa (*i. e.* a compound of oily matter and potassa,) with a little oily matter in excess.

**Yolk** is also the yellow substance found in the middle of an egg, by which the chicken is supported before its exclusion from the shell; and even afterwards, a portion being received into its belly, it is its only source of nourishment for a considerable time.

**YOUNKER**, a general name for a stripling in the service.

**YTTRIA.** This is a new earth, discovered in 1794, by Prof. Gadolin, in a stone from Ytterby in Sweden. Yttria is perfectly white when not contaminated with oxide of maganese, from which it is not easily freed. Its specific gravity is 4·842. It has neither taste nor smell.

# Z.

**Z**, the twenty-fourth and last letter of our alphabet. In abbreviations this letter formerly stood as a mark for several sorts of weights; sometimes it signified an ounce and a half, and very frequently it stood for half an ounce; sometimes for the eighth part of an ounce, or a dram troy weight; and has in earlier times been used to express the third part of an ounce, or eight scruples. ZZ were used by some of the ancient physicians to express myrrh, and at present they are often used to signify zinziber or ginger.

**ZAFFRE**, is the oxyde of cobalt, employed for painting pottery-ware and cobalt of blue colour.

**ZEA Maize**, or *Indian Corn*, in Botany, a genus of the monoecia triandria class and order, Natural order of gramina or grasses. Essential character: males in distinct spikes; calyx, glume two-flowered, awnless: corolla, glume two-flowed: awnless; female, calyx glume one-flowered, two-valved; corolla, glume four-valved; style one, filiform pendulous; seeds solitary, immersed in an oblong receptacle. There is but one species, *viz.* Z. mays, Indian corn, or maize and several varieties. *See* Maize or Maise.

**ZENITH**, an Arabic word, used in astronomy to denote the vertical point of the heavens, or that point directly over our heads. The zenith is called the pole of the horizon, being 90° distant from every point of that circle.

**Zenith** *Distance*, the arc intercepted between any celestial object and the zenith, being the same as the co-altitude of an object.

**ZEOLITE.** This stone was first described by Cronstedt in the Stockholm Transactions for 1756. It is sometimes found amorphous and crystallized. The primitive form of its crystal is a rectangular prism, whose bases are squares. The most common variety is a long four-sided prism terminated by low four-sided pyramids.

**ZERO.** The commencement of a scale of the thermometer marked 0. In Fahrenheit's thermometer, zero is 32° below freezing point. In Reaumur's thermometer, and in the centigrade thermometer, zero coincides with the freezing point of water.

**ZETETIC Method**, an old term for what we now call analytic method.

**ZIMOME.** If the gluten of wheat be treated with alcohol, it is reduced by the loss of water and gliadine to one-third of its bulk, which consists of zimome. Zimome is a shapeless mass, rough, and destitute of cohesion. It is heavier than water. It is soluble in vinegar and the mineral acids, at a boiling temperature. Zimome is found in various vegetables.

**ZINC**, in Chemistry and Mineralogy, a metal unknown to the ancients, though they were acquainted with calamine, one of its ores, and the effect which this had in converting copper into brass. Zinc has usually been ranked among those metals which, from their imperfect ductility and malleability, were long denominated semi-metals. It was known, that by uniform pressure zinc might be extended into thin plates, and, more lately, it has been discovered, that, at a certain temperature, it has so much malleability and ductility that it can be lamellated and drawn into wire.

Zinc is of a white colour with a shade of blue; in a fresh fracture it is possessed of considerable lustre. It is hard, and not easily cut with a knife. The specific gravity is nearly 7·2. The ores of zinc are calamine and blende. Calamine is an oxide, frequently with a portion of carbonic acid: blende is a sulphuret, containing also some iron and other extraneous matters. Zinc is melted by a moderate heat, and the fused mass, on cooling, forms regular crystals. Though scarcely altered by exposure to the air at a low temperature, yet it is rapidly oxydized by one amounting to ignition. When kept in a degree of heat barely sufficient for its fusion, zinc becomes covered with a grey oxide. But when thrown into a crucible or deep earthen pot, heated to whiteness, it suddenly inflames, burns with a beautiful white flame, and a white and light oxide sublimes, having considerable resemblance to carded wool. It is brittle, and has not been applied to any use. Zinc may be combined with mercury, either by triturating the metal together, or dropping mercury into melted zinc. This amalgam is used to rub on electrical machines, in order to excite electricity. Zinc combines readily with copper, and forms one of the most useful of all the metallic alloys. The metals are usually combined together by stratifying plates of copper, and native oxide of zinc combined with carbonic acid, called calamine, and applying heat. When the zinc does not exceed a fourth part of the copper, the alloy is known by the name of brass. It is of a beautiful yellow colour, more fusible than copper, and not so apt to tarnish. It is malleable, and so ductile that it may be drawn out into wire. Its density is greater than the mean. It ought to be by calculation 7·6, but it actually is 8·4 nearly, so that its density is increased by about one-tenth. When the alloy contains three parts of zinc and four of copper, it assumes a colour nearly the same with gold, but it is not so malleable as brass. It is then called pinchbeck, prince's metal, or Prince Rupert's metal. Brass was known and very much valued by the ancients. They used an ore of zinc to form it, which they called cadmia. To brass they gave the name of orichalcum. Their *æs* was copper, or rather bronze.

ZIRCON, in Mineralogy, the name of a genus containing two species, *viz.* hyacinth and zircon. It is found commonly in roundish angular pieces, which have almost always rounded angles and edges. Specific gravity about 4·6. The constituent parts are, according to Klaproth,

| | |
|---|---|
| Zirconia, | 69·0 |
| Silica, | 26·5 |
| Oxide of iron, | 0·5 |
| Loss, | 4·0 |
| | 100·0 |

ZIRCONIA, was first discovered in the jargon of Ceylon, by Klaproth, in 1789, and it has since been found in the jacinth. Zircon is a fine white powder, without taste or smell, but sometimes harsh to the touch. It is insoluble in water; yet if slowly dried, it coalesces into a semi-transparent yellowish mass, like gum-arabic, which retains one-third its weight of water. It unites with all acids. It is insoluble in pure alkalies; but the alkaline carbonates dissolve it. Heated with the blow-pipe, it does not melt, but emits a yellowish phosphoric light. There is the same evidence for believing that zirconia is a compound of a metal and oxygen, as that afforded by the action of potassium on the other earths.

ZIZANIA, a genus of plants of the class monœcia, order hexandria, and in the natural system arranged under the fourth order gramina.

ZODIAC, in Astronomy, an imaginary ring or broad circle in the heavens, in form of a belt or girdle, within which the planets all make their excursions. In the very middle of it runs the ecliptic, or path of the sun in his annual course; and its breadth, comprehending the deviations or latitudes of the earlier known planets, is by some authors accounted 16, some 18, and others 20 degrees. The zodiac cutting the equator obliquely, makes with it the same angle as the ecliptic, which is its middle line, which angle, continually varying, is now nearly equal to 23° 28′; which is called the obliquity of the ecliptic, and constantly varies between certain limits which it can never exceed.

The zodiac is divided into 12 equal parts of 30 degrees each, called the signs of the zodiac, being so named from the constellations which anciently occupied them. But the stars having a motion from west to east, those constellations do not now correspond to their proper signs; from whence arises what is called the precession of the equinoxes. And therefore when a star is said to be in such a sign of the zodiac, it is not to be understood of that constellation, but only of that dodecatemory or 12th part of it.

It is a curious fact, that the solar division of the Indian zodiac is the same in substance with that of the Greeks, and yet that it has not been borrowed either from the Greeks or the Arabians. The identity, or at least striking similarity, of the division is universally known; and Montucla has endeavoured to prove that the Bramins received it from the Arabs. His opinion has been very generally admitted; but in the second volume of the Asiatic Researches, Sir William Jones asserts that neither of these nations borrowed that division from the other; that it has been known among the Hindoos from time immemorial; and that it was probably invented by the first progenitors of that race, whom he considers as the most ancient of mankind, before their dispersion. The Greek zodiac originally contained only eleven signs; the Scorpion in their zodiac occupying the place of two.

*The Zodiacs of Esnesh and Dendera.*—These monuments represent the actual state of the heavens at the solstice period, *i.e.* the year 2782 B. C., or the year 1322 B. C., or the year 138 A. C. the solstice period being 1460 years.

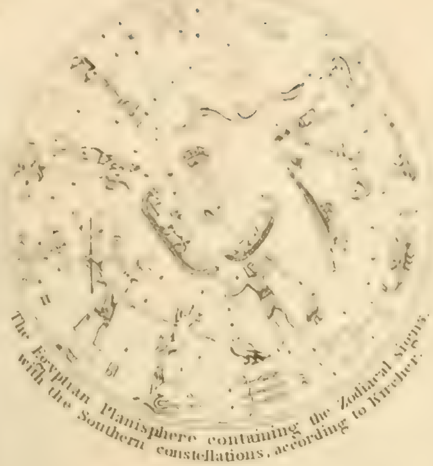
Received chronology assigns a period of 5824 years from the Creation to 1820 of the Christian æra. The Samaritan text of the scriptures makes the world to have been created 6065; the Septuagint 7210 years; and it is 7508 years since the creation, according to the testimony of Josephus. The mean of all these dates will be 6651 years, and which is perhaps not far from truth. If we adopt the chronology of the LXX. the period of 7210, from the creation to the year 1820 of our æra, may be divided thus:—2262 years from the creation to the deluge, and 3128 years from the deluge to the birth of our Saviour. With this system of chronology we shall be able to explain consistently the age of these zodiacs.

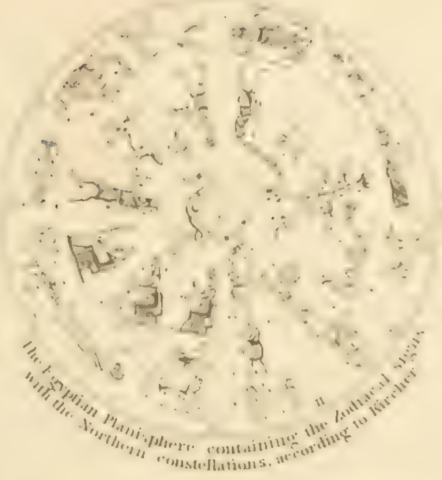
In the year 4189 of the Julian period, Cambyses conquered Egypt; at the end of 39 years the people revolted; in two years after they were compelled to submit again to their tyrants. Under the reign of Artaxerxes, about 21 years after their first emancipation, they again took arms, and drove the Persians back into Asia; in five years after, they were compelled to receive the law from a Persian satrap; but after an interval of 80 years they revolted a third time, and resisted their invaders for 25 years; at length they yielded; and in the eighteenth year following, Egypt submitted to the arms of Alexander. During these wars the sciences ceased to flourish; priests and learned men were sacrificed by Cambyses; the temples of the gods were defaced, their images mutilated; and if in the most splendid eras of her prosperity the priests of Egypt never imparted their knowledge to the public, there is little ground to suppose that the remnant who guarded its last faint embers would be willing the conquering Greeks should light the torch of science in the dying flame. But when, where, and by whom the severer sciences of geometry and astronomy, as transmitted by the Egyptians to the Greeks, were constructed, is not easy to decide. At some remote period there were mathematicians and astronomers who knew the sun to be the centre of the planetary system, and that the earth, itself a planet, revolves round the central fire; who described the orbits, and calculated the returns of comets; who indicated the number of solar years contained in the great circle, by multiplying a period of 180 years by another period of 144 years; who reckoned the sun's distance from the earth by a measurement equal to 800,000,000 Olympic stadia, and who must therefore have taken the parallax of that luminary by a method little inferior to that now in use, and certainly much more correct than that adopted by Hipparchus; who fixed the moon's distance from the primary planet at 59 semidiameters of the earth; who had measured the circumference of our globe with so much exactness, that their calculations only differed by a few feet from that made by our modern geometricians; who held that the Moon and the other planets were worlds like our own, and that the Moon was diversified by valleys, mountains, and seas; who asserted that there was yet a planet which revolved round the Sun, beyond the orbit of Saturn; who reckoned the planets to be 16 in number; and who calculated the length of the tropical year within three minutes of the true time.—(*See Sir W. Drummond's Essay on the Science of the Egyptians and Chaldeans.*

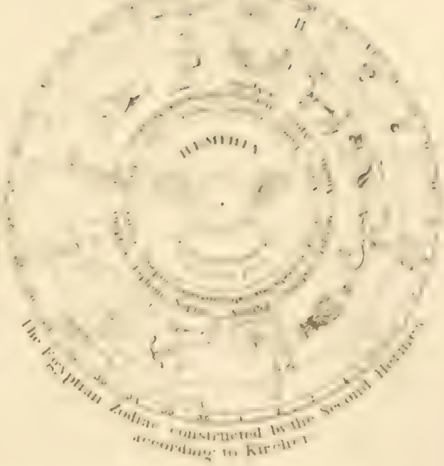
Before the deluge, men lived usually 800 or 900 years. In so many years every individual had time to make great progress in knowledge; he could devote whole centuries to any one pursuit; during as many centuries he could verify his experiments; and if a large proportion of society was then raised above the pressure of actual want, the arts and sciences of the descendants of Noah were in all probability as well known in the 2262 years that elapsed between the creation and the deluge, as in a few centuries they have reached so much excellence in modern times.

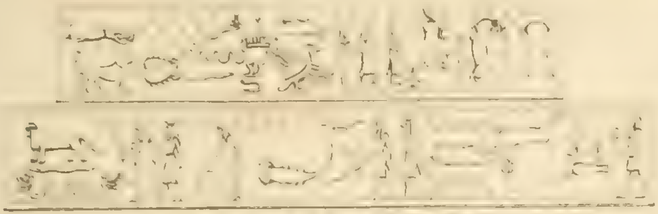
Indeed, the Jews, Syrians, and Arabians, have numerous traditions of the astronomical knowledge of Adam, Seth, Enoch, and Ham. Seth lived 912 years, and to him the Hebrews ascribe the invention of astronomy. He is the Egyptian Thoth. During 720 years he could observe the stars, which, in

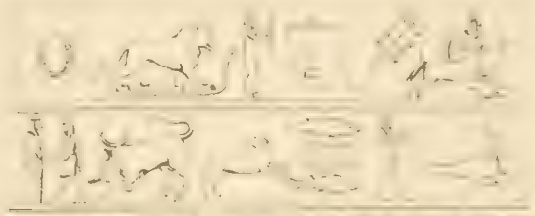
# ANCIENT ZODIACS.

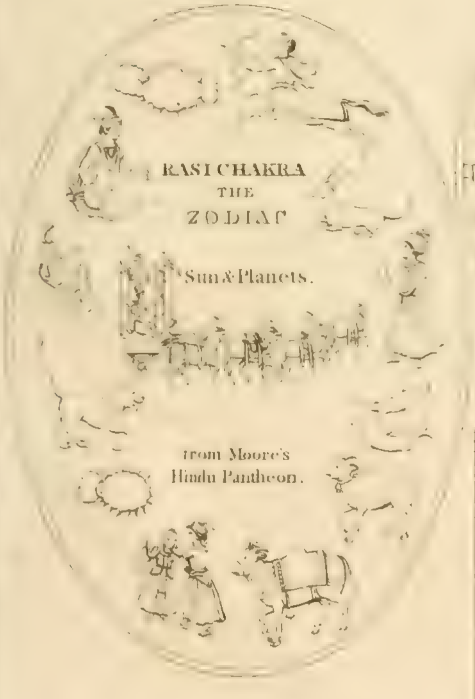

The Egyptian Planisphere containing the Zodiacal signs with the Southern constellations, according to Kircher.


The Egyptian Planisphere containing the Zodiacal signs with the Northern constellations, according to Kircher.


The Egyptian Zodiac constructed by the Second Hermes according to Kircher.


The Zodiac of Esne Latopolis.


The Egyptian Zodiac from the Ceiling of the Grand Portico in the Temple of Isis at Dendera.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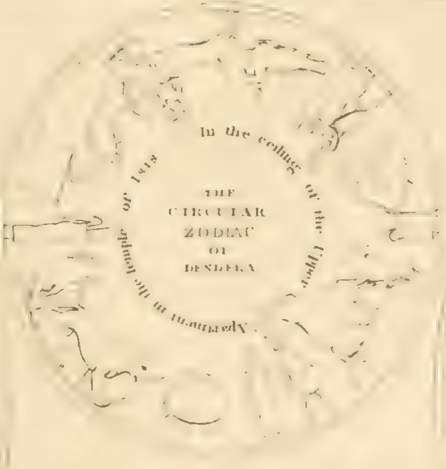
Sun & Planets.

from Moore's
Hindu Pantheon.


THE
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OF
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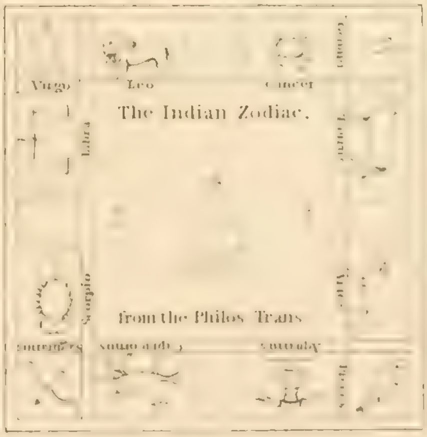
In the ceiling of the Upper Apartment in the temple of Isis


The Indian Zodiac.

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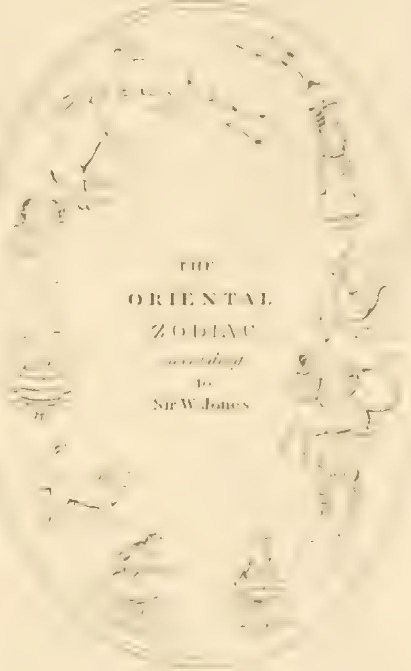
THE
ORIENTAL
ZODIAC
according
to
Sir W. Jones

this period, would have moved forwards 10°, or ⅓ of a sign. The descendants of Noah advanced in different directions from a common centre; hence we find all the Oriental nations in possession of a zodiac with 12 signs, with the exception of the Chaldeans, who were followed in this by the Alexandrian Greeks, who counted only 11, allotting 60° to Scorpius, and not admitting Libra, one common model must have served all these people and nations, for the emblems are all alike, and a single glance at the plate will set this matter at rest. Moreover, the Japetus of the Greeks, father of Altus, who is said to have invented the armillary sphere, is none other than the Hebrew scripture Japhet; and thus the testimony of the Greeks proves, that the immediate descendants of Noah were versant in astronomy, in which it is clear they must have been instructed by the patriarch and his sons.

Though the Chaldeans always divided their zodiac into 11 signs, the Scorpion perhaps occupying two signs, as is alluded to by Ovid, lib. ii. v. 197, Metam.

> " *Scorpios* ——————————
> *Porrigit in spatium signorum membra duorum.*"

But the Egyptians parcelled it into 12 signs, over which 12 gods presided. " *Ægyptii*," inquit Servius, " *duodecim esse asserunt signa: Chaldæi vero undecim; nam Scorpium et Libram unum signum accipiunt; Chelæ Scorpii Libram faciunt.*"

Yet, though we ascribe the division of the stars into constellations to the antediluvians, and assign to them the invention of the zodiac, it does not follow that the postdiluvian emblems and signs were identically the same as those which had obtained before the deluge. Amidst these changes, the Egyptians, the descendants of Ham or Cham, having adopted the worship of the host of heaven, would naturally choose such names and symbols as suited their purposes and situation; and while they retained the ancient divisions of the zodiac, they probably altered some of the emblems by which it was represented.

Every thing in the zodiac of Dendera seems to prove that it owed its existence to the natives of the soil, and could not have been constructed in the age of Adrian and Antoninus Pius. The emblems and figures are all Egyptian. There is nothing Greek in the designs. All is Egyptian—astronomy, mythology, symbols, taste, style, manner.

The sun's place in the oblong zodiac of Dendera is indicated at the division of the two scarabæ, or beetles. The small scarabæus is next to Gemini, and the larger scarabæus next to Leo. The former represents the ascending part of the sign Cancer, the latter the descending part of the same sign. The relative proportions of these beetles is as 17 to 13, or perhaps as 16 to 14. We consequently fix the date of this zodiac at the time when the solstitial colure corresponded with the 14th degree of the dodecatemorion of Cancer, according to the real zodiac. This nearly corresponds to the first year of the solstice period of which the Thoth, or beginning, may be fixed for the year 1322 B. C. It is now 2160 years since the sun at the summer solstice quitted the dodecatemorion of Cancer, according to the precession of the equinoxes. And if to these 2160 years we add the 16° of ♋ descending, we shall give an existence of 3312 years, at least, to the oblong zodiac of Dendera. The book of Job has a higher antiquity than this, if, as is generally supposed, it was written 1700 years before our æra. Leo, however, was once a solstitial sign; Taurus, then, opened the year. This was 2500 years B. C. The lion Hercules then sprung from Typhon. How did it travel from Egypt to Argolis? Thus:—the Nemean games were celebrated at the season when the sun in his annual course is in the sign of Leo. The *Hercul*, (universal heat) the sun, took possession of the sign Leo, at the period of this annual festival. And why might not an Egyptian colony have settled at Argolis four or five centuries after the deluge? There is no difficulty in giving an affirmative answer, if the chronology of the LXX. be adopted. The Persian symbol of a bee entering the mouth of a lion, commonly known as the Mithraic lion, represents the sun entering Leo; and this symbol may be referred to the period when the sun at the summer solstice was in the first degree of Leo.

The Egyptians began their sacred year with the heliacal rising of Sirius, Siris, or Sothis, the star of Isis. The dog-star is near Cancer, with which in Egypt it rises cosmically: the Roman year commenced with Aquarius; that of the Egyptians with Cancer. But I here observe, that Soth, a name of the dog-star, was also the name of an Egyptian divinity named Thoth, who also presided over this star; and Thoth seems to be the same with the Seth of scripture.

Oriental scholars interpret Seth *Thoth, Shoth, Thist*, by *posuit, ponere;* and assert, that Seth, Soth, and Thoth, were only different names for the patriarch whom the Hebrews, Syrians, and Arabians, consider as the institutor of the sciences. Who has not heard of the two columns of stone and brick, erected by the descendants of Seth, and which Josephus pretends to have existed still in the land of Siriad in his time? Manetho, who flourished 300 years before Josephus, says, he took his history from the columns placed in the Siriadi land, which had been inscribed in the sacred dialect, and in hieroglyphical characters, by Thoth, the first Hermes, before the deluge! And the Arabians have a tradition, that Hermes, or Thoth, invented his books, or rather tables of brass or stone, in one of the pyramids, before the deluge. Sir W. Drummond thinks *Nubia* was *Siriad;* because the Nile, above Syene, was called *Siri*, or *Siris*. Perhaps the name of Seth, which the Egyptians corrupted into Thoth, which signifies the *basis*, and which, as a proper name, might indicate him who first established the civil year, was given to the patriarch who bore it, because he was the founder of the second race that sprang from Adam, and in the persons of Noah and his family were to repeople the world.

ZODIACAL LIGHT, a brightness sometimes observed in the zodiac, resembling that of the galaxy or milky way. It appears at certain seasons, *viz.* towards the end of winter, and in spring after sun-set, or before his rising in autumn, and beginning of winter, resembling the form of a pyramid, lying lengthways with its axis along the zodiac, its base being placed obliquely with respect to the horizon.

The zodiacal light, according to Mairan, is the solar atmosphere, a rare and subtile fluid, either luminous by itself, or made so by the rays of the sun surrounding its globe, but in a greater quantity, and more extensively, about his equator, than any other part. Mairan says, it may be proved from many observations, that the sun's atmosphere sometimes reaches as far as the earth's orbit, and there meeting with our atmosphere produces the appearance of an aurora borealis.

The length of the zodiacal light varies sometimes in reality, and sometimes in appearance only, from various causes.

Cassini often mentions the great resemblance between the zodiacal light and the tails of comets. The same observation has been made by Fatio; and Euler endeavoured to prove that they were owing to similar causes. See " Decouverte de la Lumiere Celeste que paroit dans le Zodiaque," art. 41. Lettre a M. Cassini, printed at Amsterdam in 1686. Euler, in Mem. de l'Acad. de. Berlin, tom 2. This light seems to have no other motion than that of the sun itself; and its extent from the sun to its point is seldom less than 50 or 60 degrees in length, and more than 20 degrees in breadth; but it has been known to extend to 100 or 103°, and from 8° to 9° broad.

It is now generally acknowledged, that the electric fluid is the cause of the aurora borealis, ascribed by Mairan to the solar atmosphere, which produces the zodiacal light, and which is thrown off chiefly, and to the greatest distance, from the equatorial parts of the sun, by means of the rotation on his axis, and extending visibly as far as the orbit of the earth, where it falls into the upper regions of our atmosphere, and is collected chiefly towards the polar parts of the earth in consequence of the diurnal revolution, where it forms the aurora borealis. And hence it has been suggested as a probable conjecture, that the sun may be the fountain of the electrical fluid, and that the zodiacal light, and the tails of comets, as well as the aurora borealis, the lightning, and artificial electricity, are its various and not very dissimilar modifications. See Biot D'Astronomie Phisique, art. 254; and Gregory's Translation of Haüy's Philosophy, vol. ii. art. 628.

ZONE, in Geography and Astronomy, a division of the earth's surface, by means of parallel circles, chiefly with respect to the degree of heat in the different parts of that surface. The ancient astronomers used the term zone to explain the different appearances of the sun and other heavenly bodies, with the length of the days and nights; and the geographers, as they used the climates, to mark the situation of places; using the term climate, when they were able to be more exact, and the term zone when less so. The zones were commonly accounted five in number; one a broad belt round the middle of the earth, having the equator in the very middle of it, and bounded towards the north and south by parallel circles passing through the tropic of Cancer and Capricorn. This they called the torrid zone, which they supposed not habitable on account of its extreme heat. Though sometimes they divided this into two equal torrid zones by the equator, one to the north, and the other to the south; and then the whole number of zones was accounted six. Next from the tropic of Cancer and Capricorn, to the two polar circles, were two other spaces, called temperate zones, as being moderately warm; and these they supposed to be the only habitable parts of the earth. Lastly, the two spaces beyond the temperate zones, about either pole, bounded within the polar circles, and having the poles in the the middle of them, are the two frigid or frozen zones, and which they supposed not habitable on account of the extreme cold there. Hence, the breadth of the torrid zone is equal to twice the greatest declination of the sun, or obliquity of the ecliptic, equal to 46° 56′, or twice 23° 28′. Each frigid zone is also of the same breadth, the distance from the pole to the polar circle being equal to the same obliquity, 23° 28°. And the breadth of each temperate zone is equal to 43° 4′, the complement of twice the same obliquity. The difference of zones is attended with a great diversity of phenomena. 1. In the torrid zone, the sun passes through the zenith of every place in it twice a year; making as it were two summers in the year; and the inhabitants of this zone are called Amphiscians, because they have their noon-day shadows projected different ways in different times of the year, northward at one season, and southward at the other. 2. In the temperate and frigid zones the sun rises and sets every natural day of 24 hours. Yet every where, but under the equator, the artificial days are of unequal lengths, and the inequality is the greater as the place is farther from the equator. The inhabitants of the temperate zones are called Heteroscians, because their noon-day shadow is cast the same way all the year round, viz. those in the north zone towards the north pole, and those in the south zone towards the south pole. 3. Within the frigid zones the inhabitants have their artificial days and nights extended out to a great length; the sun sometimes skirting round a little above the horizon for many days together; and at another season never rising above the horizon at all, but making continual night for a considerable space of time. The inhabitants of these zones are called Periscians, because sometimes they have their shadows going quite round them in the space of 24 hours.

**ZOOLOGY**, is that part of natural history which relates to animals. Linnæus divides the whole animal kingdom into six classes, *viz.* *Mammalia*, includes all animals that suckle their young. *Aves*, or birds. *Amphibia*, or amphibious animals. *Pisces*, or fishes. *Insecta*, or insects. *Vermes*, or worms. The first class, *Mammalia*, is subdivided into seven orders. *See* MAMMALIA.—The second class *Aves*, is subdivided into six orders. *See* AVES.—The third class, *Amphibia*, is divided into two orders. *See* AMPHIBIA.—The fourth class, *Pisces*, is subdivided into six orders. *See* PISCES.—The fifth class, *Insects*, is subdivided into seven orders. *See* INSECT.—The sixth class, *Vermes*, is divided into five orders. *See* VERMES.—For more particular information concerning the several branches and subjects of zoology, the reader may consult the various articles above referred to, and he will find most of the genera described in their order in the alphabet.

**ZOONATES.** Combinations of the zoonic acid with the salifiable basis.

**ZOONIC**, is the liquid procured by distillation from animal substances, which had been supposed to contain only carbonate of ammonia and an oil.

**ZOOPHYTA**, in Natural History, an order of the class vermes. Zoophyta are composite animals holding a medium between animals and vegetables. Most of them take root and grow up into stems, multiplying life in their branches and deciduous buds, and in the transformation of their animated blossoms or polypes, which are endowed with spontaneous motion. Plants therefore resemble zoophyta, but are destitute of animation and the power of locomotion; and zoophyta are, as it were, plants, but furnished with sensation and the organs of spontaneous motion. Of these some are soft and naked, and others are covered with a hard shell: the former are by some naturalists called zoophytes, and the latter are denominated lithophytes. The coral reefs that surround many islands, particularly those in the Indian Archipelago, and round New Holland, are formed by various tribes of these animals, particularly by the Cellepora, Isis, Madrepora, Millepora, and Tubipora. The animals form these corals with such rapidity, that enormous masses of them very speedily appear where there were scarcely any marks of such reefs before.

**ZOPISSA**, *Naval Pitch*, a mixture of pitch and tar scraped from the bottoms of ships that have been long at sea. This composition, by having been gradually penetrated by the salt of the sea, becomes impregnated with its qualities; and being applied to the body externally, is found resolutive and desiccative.

**ZUMIC ACID**, a name given to a peculiar acid principle lately obtained from rice.

FINIS.

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